A PRELIMINARY YIELD MODEL FOR NATURAL *YUSHANIA ALPINA* BAMBOO IN KENYA

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INTRODUCTION

Bamboo is the fastest growing plant on earth with a short growth cycle. Some species grow as much as 1.2 m per day. Its yield is up to 25 times higher than that of fastest growing timber trees. It can be harvested in 3-5 years cycles versus 10-50 years for most softwoods and hardwoods. One bamboo clump can produce 200 poles in the five years it takes one tree to reach maturity.

Bamboo is a viable replacement for wood and is one of the strongest building materials, with a tensile strength that rivals steel. It is a critical element in the balance of oxygen and carbon dioxide in the atmosphere. It helps reduce the carbon dioxide gases blamed for global warming with some bamboo sequestering up to 12 tons of carbon dioxide from the air per hectare, which makes it an extremely efficient replenisher of fresh air (Isagi *et a*l 1997). Bamboo also mitigate water pollution due to its high nitrogen consumption, making it the perfect solution for excess nutrient uptake of waste water from manufacturing, intensive livestock farming, and sewage treatment facilities.

The natural bamboo resources in Kenya are about 150,000 ha and are divided into six categories: bamboo with trees and shrubs, bamboos with trees, bamboos with shrubs, pure bamboo, shrubs with bamboos and alpine vegetations, moorland and bamboos (Kant *et al* 1992). They are mainly found on the mountain slopes in the high potential areas in Mt Kenya, Aberdares ranges, Mau escarpment, Cherangani hills and Mt Elgon at high elevations between 2300 and 3200 meters above sea level.

There is only one indigenous bamboo species, *Yushania alpina* (formerly *Arundinaria alpina*) in Kenya (Figure 1). It grows in single culms grouped into clumps. Results of studies by (Wimbush 1947, Kant *et al* 1992 and Kigomo 1994, 1995, 1988 and 2007) showed that *Y. alpina* attains a mean total height of 14 to 15 m, mean diameter of 6.0 cm. The study by Wimbush reports the average air-dry weight of *Y. alpina* culms is 100 tons per ha (Wimbush 1947) comprising of 10000 to 17000 culms ha^{-1}. The same study reports the average cellulose content of *Y. alpina* culm is 47.5 per cent. A study by Ongugo *et al* (1999) reports the average length of a *Y. alpina* culm as 10.2 m and a dbh of 7.5 cm. Results of the study by Kant *et al* (1992) gives the mean weight of *Y. alpina* culm as 10 kg.

The main use of *Y. alpina* bamboo in Kenya is construction and fencing. Currently there is high demand for bamboo for use in horticulture farming, handcraft, residential fencing, and cottage industry for making furniture, baskets, tooth picks and match sticks. Some companies have also expressed interest in using large amounts of bamboo for furniture, bio-energy, panels, particle boards and pulp. However, bamboo raw material is not available for use because of a Presidential ban imposed on harvesting of wood and bamboo resources in all Government and Trust lands in 1986. But even if the ban was lifted, harvesting of bamboo in the natural forests cannot be prudent because there is very little information on the quantity, quality and geographical distribution of the available amount. The only information available on bamboo yields indicates that a well-managed natural stand of *Y. alpina* can produce 6 to 10 tons of mature and 1200 new culms $ha^{-1}yr^{-1}$ (Kant *et al* (1992).

Figure 1. *Yushania alpina* at Kieni Forest

As mentioned above, many entrepreneurs have continued to request the Government through Kenya Forest Service (KFS) to be allowed to extract natural bamboo for various uses. On the other front Kenya Forestry Research Institute (KEFRI) has vigorously continued to promote growing and intensive use of bamboo. These two noble ideas cannot be realized in the absence of the bamboo resource data. The objective of this study was to develop a yield model that can be used to estimate total bamboo culms biomass in a given area and the proportion that can be harvested on a sustainable basis.

MATERIALS AND METHODS

The field data were collected from 25 temporary sample plots in natural pure *Y. alpine* and *Y. alpina* and trees vegetation types at Kieni (Thika dstrict), Kamae and Kinale (Kiambu district) forest stations in June 2008. The plots were rectangular (10 m x 20 m) with the longer side expressing the slope. They were geo-referenced and located on the flat ground on the ranges where bamboo is likely to be harvested.

All bamboo clumps in a plot were identified and the culms classified and tallied in four categories: old, mature, young and dead. The old were those covered by mold and greenish brown in colour, mature those greenish brown in colour and without mold, young were green in colour and without mold and dead those dry without foliage. However, the classification was not discrete in regards to transition from old to mature and young. From each of the first three categories, three culms were randomly selected and diameter at breast height (dbh) measured. The culms were then felled and the following parameters determined: total height, merchantable height to a top diameter of 2.5 cm and green weight (Figure 2).

Figure 2. Measurement of green weight of bamboo culms

Samples for determination of moisture content and basic density were obtained by strategically extracting billets to include the portion 10 cm below and 10 cm above the first node at the upper side of the dbh measurement point. The samples were packed in water proof polythene bags (Figure 3) and transported to KEFRI laboratory at Karura Research Centre. Two discs, each 25 mm long were extracted from each billet, weighed separately and immersed in water to obtain green volume. The discs were then oven dried at 103^0 C until a constant weight was obtained.

The oven dry moisture content and basic density were calculated using the following formulae:

Moisture content (%) = [(Initial weight- Oven dry weight) x 100]/ Oven dry weight*Eq. 1*
Basic density (Kgm^{-3}) = [Oven dry weight/green volume]…………………………...*Eq. 2*

Figure 3. Samples packed in water proof polythene bags

Graphical presentations of the culm merchantable weight as a function of dbh and merchantable height were used to identify the general form of the functions to be fitted to the data. The linear regression functions were found most suitable. The culm merchantable green weight was estimated as a function of dbh, merchantable height, basic density, and moisture content using SPSS version 15 to estimate parameters in the equations. The contribution by each of the dependent variables was tested stepwise and those found significant (at P=0.05) retained. The best model was selected based on the following criteria:

- the adjusted R^2, – models with the highest adjusted R^2 were preferred;

- residual mean square (RMS) – models with lowest RMS; and

The following five models were fitted:

i) w = a+bd
ii) w=a+bh
iii) w= a + bd*h
iv) mc = a+bd
v) usable wg =a+bd*h-mc

where, w = culm merchantable green weight, d = culm dbh, h = culm merchantable height, mc = culm moisture content, d = culm basic density at dbh, and *a* and *b*, are estimated regression coefficients.

RESULTS

More than half of the sample plots (Table 1) were located at Kieni at an elevation between 2401 to 2643 m.a.s.l, which is within the range for natural forests bamboo in East Africa.

Table 1. Geographical location of plots

		GPS readings		
Forest Station	**Plot No.**	**Northing**	**Easting**	**Altitude**
Kieni	1	00 51750	3641920	2467
Kieni	2	00 51782	3641048	2479
Kieni	3	00 51817	3641227	2459
Kieni	4	00 51796	3643135	2401
Kieni	5	0051807	3641239	2460
Kieni	6	0051776	3641136	2484
Kieni	7	0051464	3640270	2509
Kieni	8	0051447	3640299	2511
Kieni	9	0051441	3640295	2521
Kieni	10	0051258	3640596	2537
Kieni	11	0052306	3640525	2516
Kinale	12	0052403	3640556	2543
Kieni	13	0052449	3640476	2553
Kinale	14	0052526	3640449	2552
Kieni	15	0052541	3640238	2566
Kieni	16	0052550	3640136	2517
Kinale	17	0052610	3640128	2540
Kieni	18	0052619	3640390	2562
Kieni	19	0052599	3640013	2566
Kieni	20	0052643	3639893	2558
Kamae	21	0050872	3638122	2612
Kamae	22	0050903	3638171	2611
Kamae	23	0050921	3638223	2643
Kamae	24	0050908	3638265	2622
Kamae	25	0050866	3638291	2628

Stocking

The culms mean stoking density calculated from the data in 25 sample plots was 20916 ha^{-1} and varied from 12650 to 36900 (Table 2). The distribution by age class was 60.1 % old; 21.6 % mature; 9.9 % young; and 8. 4 % dead. The mean dbh ranged from 5.2 cm for young to 5.3 cm for the old ones. However, the mean dbh for the dead culms was not included.

Merchantable green weight

The culms mean merchantable green weight ranged from 8.3 kg for the young ones to 9.6 kg for the old (Table 3). Merchantable height ranged from 8.1 m for the old to 8.4 m for the mature ones. Analysis of variance (Tables 4 and 5) showed that there were no significant differences ($P<0.005$) among the means of the culms by age class in dbh, merchantable green weight, merchantable height and total height.

Moisture content and basic density

The mean moisture content of sampled culms ranged from 29.3 % to 457.2 % with an overall plot mean of 154.4 % (Tables 5). The young culms had the highest mean moisture content of 283.2 %, while the old ones had the least at 85.8 % (Table 6). The culms mean basic density was 0.5gcm^{-3} and ranged from 0.2 to 1.0 gcm^{-3}. Basic density increased significantly ($P<0.005$) with age with the young culms having a mean of 0.3 gcm^{-3} and the old 0.7 gcm^{-3} (Table 6).

Table 2. *Yushania alpina* stocking at Kieni, Kamae and Kinale forest stations

Plot No.	*No. of culms*	*No. of culms ha^{-1}*	*Percentage*			
			Old	**Mature**	**Young**	**Dead**
1	423	21150	68.3	22.7	1.9	7.1
2	352	17600	64.8	24.7	6.5	4.0
3	401	20050	45.4	29.4	17.2	8.0
4	412	20600	52.4	15.5	13.1	18.9
5	559	27950	49.0	21.1	15.9	14.0
6	354	17700	55.6	22.0	10.2	12.1
7	463	23150	78.6	10.2	8.6	2.6
8	500	25000	56.4	31.2	7.0	5.4
9	491	24550	56.6	28.7	10.4	4.3
10	327	16350	48.6	41.9	1.5	8.0
11	378	18900	51.6	24.9	0.0	23.5
12	501	25050	48.1	23.0	15.6	13.4
13	738	36900	43.4	24.8	16.0	15.9
14	509	25450	59.9	13.9	11.6	14.5
15	487	24350	57.3	28.7	5.3	8.6
16	253	12650	62.5	28.1	0.0	9.5
17	398	19900	45.7	36.2	7.8	10.3
18	422	21100	60.0	27.7	5.9	6.4
19	281	14050	74.7	6.8	3.6	14.9
20	431	21550	78.7	10.4	4.2	6.7

21	306	15300	68.0	20.3	9.8	2.0
22	262	13100	67.6	13.4	19.1	0.0
23	342	17100	76.6	3.5	19.9	0.0
24	347	17350	75.5	8.6	15.9	0.0
25	521	26050	58.0	21.3	20.7	0.0
Mean	418	20916	60.1	21.6	9.9	8.4

Table 3. Descriptive statistics of *Yushania alpina* culms at Kieni, Kamae and Kinale forest stations

Culm class	Statistic	Dbh, cm	Merchantable height , m	Total Height, m	Weight, kg
Old	Mean	5.4	8.1	10.5	9.6
	N	75.0	75.0	75.0	75.0
	Std. Deviation	0.7	1.7	1.7	3.4
	Minimum	4.0	4.6	6.0	3.0
	Maximum	7.0	13.7	13.6	19.5
	Std. Error of Mean	0.1	0.2	0.2	0.4
Mature	Mean	5.3	8.4	11.0	9.1
	N	75.0	75.0	75.0	75.0
	Std. Deviation	0.8	1.9	1.9	3.5
	Minimum	3.3	4.2	4.8	3.0
	Maximum	7.4	13.5	14.0	17.5
	Std. Error of Mean	0.1	0.2	0.2	0.4
Young	Mean	5.2	8.2	10.9	8.3
	N	69.0	69.0	69.0	69.0
	Std. Deviation	1.0	2.2	2.0	3.5
	Minimum	2.8	2.4	4.8	0.6
	Maximum	7.0	12.4	14.2	16.5
	Std. Error of Mean	0.1	0.3	0.2	0.4

Table 4. Analysis of variance of dbh, merchantable height, total height and green weight of *Yushania alpina* culms at Kieni, Kamae and Kinale forest stations

Variable	Source	Sum of Squares	df	Mean Square	F	Sig.
Dbh, cm	Between Groups	1.2	2.0	0.6	0.9	0.4
	Within Groups	151.1	216.0	0.7		
	Total	152.3	218.0			
Total Height, m	Between Groups	9.7	2.0	4.9	1.4	0.3
	Within Groups	751.6	216.0	3.5		
	Total	761.3	218.0			
Merchantable height, m	Between Groups	2.7	2.0	1.3	0.4	0.7
	Within Groups	819.1	216.0	3.8		
	Total	821.8	218.0			
Green weight, kg	Between Groups	54.2	2.0	27.1	2.3	0.1
	Within Groups	2576.0	216.0	11.9		
	Total	2630.2	218.0			

Table 5: Descriptive statistics of moisture content and basic density of *Yushania alpina* culms at Kieni, Kamae and Kinale forest stations

		Moisture content, %					Basic density, gcm^{-3}				
Plot No.	**N**	**Mean**	**Std. Dev**	**Std. Error**	**Min**	**Maxi**	**Mean**	**Std. Dev**	**Std. Error**	**Minimum**	**Maximum**
1	9	136.2	96.4	32.1	35.0	271.2	0.54	0.20	0.07	0.29	0.84
2	9	143.0	111.1	37.0	58.0	368.6	0.56	0.21	0.07	0.23	0.78
3	9	157.6	104.2	34.7	29.3	319.1	0.49	0.18	0.06	0.25	0.69
4	9	151.0	99.8	33.3	59.2	348.3	0.53	0.22	0.07	0.23	0.95
5	9	158.1	97.0	32.3	60.8	312.9	0.51	0.20	0.07	0.26	0.78
6	8	147.8	102.8	36.3	57.3	318.1	0.58	0.23	0.08	0.25	0.80
7	9	160.3	85.9	28.6	80.2	324.7	0.48	0.16	0.05	0.24	0.70
8	9	147.6	71.8	23.9	71.0	254.3	0.49	0.15	0.05	0.29	0.71
9	9	142.3	85.1	28.4	66.0	296.8	0.52	0.18	0.06	0.26	0.74
10	9	151.9	47.7	15.9	86.3	251.5	0.46	0.10	0.03	0.28	0.65
11	6	82.6	16.0	6.6	60.5	101.9	0.65	0.08	0.03	0.56	0.77
12	9	166.8	136.1	45.4	72.1	457.2	0.51	0.20	0.07	0.18	0.69
13	9	148.7	122.1	40.7	62.9	357.2	0.55	0.21	0.07	0.22	0.75
14	9	120.8	85.2	28.4	53.4	257.5	0.62	0.23	0.08	0.29	0.85
15	9	179.4	138.6	46.2	61.1	366.0	0.51	0.23	0.08	0.22	0.78
16	6	113.8	50.7	20.7	75.0	209.1	0.57	0.13	0.05	0.35	0.71
17	9	145.8	103.4	34.5	48.4	333.2	0.55	0.22	0.07	0.24	0.85
18	9	195.7	139.8	46.6	76.8	395.0	0.47	0.21	0.07	0.21	0.69
19	9	187.0	124.9	41.6	68.2	373.8	0.48	0.21	0.07	0.22	0.72
20	9	165.9	127.8	42.6	55.0	354.9	0.54	0.25	0.08	0.22	0.81
21	9	158.6	82.8	27.6	83.5	280.3	0.48	0.16	0.05	0.27	0.65
22	9	165.6	88.0	29.3	84.5	307.0	0.47	0.15	0.05	0.26	0.65
23	9	156.7	106.0	35.3	77.4	346.2	0.51	0.18	0.06	0.23	0.67
24	9	161.6	80.6	26.9	92.6	310.2	0.47	0.14	0.05	0.25	0.61
25	9	176.1	99.2	33.1	90.0	315.3	0.45	0.15	0.05	0.25	0.62
Mean	218	154.4	98.2	6.6	29.3	457.2	0.52	0.19	0.01	0.18	0.95

Table 6. Descriptive statistics of oven dry weight, basic density and moisture content of *Yushania alpina* culms by age class at Kieni, Kamae and Kinale forest stations

Parameter	**Culm class**	**N**	**Mean**	**Std. Dev**	**Std. Error**	**Min**	**Max**
Oven dry weight, kg	Old	75.0	5.2	2.0	0.2	1.9	12.1
	Mature	75.0	4.6	1.9	0.2	1.3	12.2
	Young	69.0	2.3	1.1	0.1	0.2	6.1
	Total	219.0	4.1	2.1	0.1	0.2	12.2
Basic density, gm-^{3}	Old	75.0	0.7	0.1	0.0	0.4	0.9
	Mature	74.0	0.6	0.1	0.0	0.4	1.0
	Young	69.0	0.3	0.1	0.0	0.2	0.8
	Total	218.0	0.5	0.2	0.0	0.2	1.0
Moisture content, %	Old	75.0	85.8	26.6	3.1	29.3	215.2
	Mature	74.0	103.8	32.1	3.7	35.0	209.1
	Young	69.0	283.2	63.8	7.7	67.0	457.2
	Total	218.0	154.4	98.2	6.6	29.3	457.2

Linear Regression models for predicting merchantable green weight and oven dry weight of *Y. alpine*

The best linear regression model for predicting green weight of *Yushania alpina* culms based on dbh (Table 8) is:

$$W= -1.11 + 0.36 D^2 \quad \text{......................................} \quad \textit{Eq. 3}$$

Where, W = culm merchantable green weight, D = culm dbh, cm.

Table 8: Linear regression models for predicting merchantable green weight of *Yushania alpina* culms based on dbh, merchantable height, and total height

Model	*N*	*Constant*	*coefficient*	*Adjusted R Square*	*Std. Error of the Estimate of R*	*F-value*	*Significance*
Dbh^2	218	-1.11	0.36	0.82	1.45	976.02	0.00
Dbh	218	-10.64	3.74	0.81	1.52	914.25	0.00
Dbh*merchantable height	218	0.26	0.20	0.79	1.58	834.47	0.00
Merchantable height	218	-2.29	1.37	0.59	2.23	312.46	0.00
Merchantable $height^2$	218	3.26	0.08	0.57	2.31	276.17	0.00
Total $height^2$	218	2.03	0.06	0.41	2.66	154.16	0.00
Total height	218	-3.28	1.14	0.37	2.75	130.90	0.00

The best linear regression models for predicting oven dry weight of *Yushania alpina* culms based on green weight and dbh is equation 4 and the statistics are presented in Table 9.

$$ODW = 1.04 + 0.06(dbh*gw) \text{ ------} \textit{Eq. 4}$$

Where, ODW = culm merchantable oven dry weight, kg, dbh = diameter at breast height and gw=green weight.

Table 9. Linear regression models for predicting oven dry weight of *Yushania alpina* culms based on green weight, dbh and total height

Model	*N*	*Constant*	*coefficient*	*Adjusted R Square*	*Std. Error of the Estimate of R*	*F-value*	*Significance*
Dbh^2	218	-0.213	0.151	0.39	1.66	140.6	0.000
Dbh	218	-4.33	1.16	0.39	1.65	142.43	0.000
Merchantable height	218	-0.86	0.60	0.30	1.78	93.25	0.000
green weight	218	-0.21*	0.47	0.60	1.34	329.07	0.000
green $weight^2$	218	1.58	0.04	0.28	1.80	54.89	0.000
Green weight*dbh	218	1.04	0.06	0.55	1.42	267.67	0.000

*Not significant

Discussion

The culms mean stoking density (21000 culms ha^{-1}) in this study is one and half times that reported in earlier studies in the same geographical area (Wimbush, 1945; Kigomo 1995, 1988, 2007 and 2008, Kant *et al*). The possible reason is that there has been no harvesting of bamboo culms in the study area for more than a decade, which is more than the life cycle of bamboo.

This may also tell why the culm mean dbh is lower than that reported by earlier studies. The mean weight of old *Y. alpina* culm (9.6 kg) calculated in this study is in line with that reported by Kant *et al* (1992).

The total number of the old culms and their green merchantable weight is 12600 and 121 tons ha^{-1}, respectively. The mean oven dry weight of the same culms is 70 tons ha^{-1} and is in line with the 100 kg ha^{-1} air dry biomass reported by Wimbush (1945). The merchantable green weight of culms is comparable to 116.5 tons ha^{-1} of the above ground biomass of the *Phyllostachys pubescens* (the largest bamboo species in the World) reported by Isagi (1994).

Just like the case with all living things, *Y. alpina* culm stops growing as they age. Consequently, the old and dead culms which accounts for 60.1 % and 8.4 % of the total green merchantable culms, respectively do not put on new growth. It would therefore be prudent that these culms are harvested to supply raw material to many individuals and companies that have expressed interest in harvesting large amounts of bamboo for various uses. Nonetheless, the proponents of the environment may raise concern that cutting 68.5 % of bamboo may expose the environment to rainfall run-off, and loss of soil and ground moisture. This would interfere with the water availability in the region because natural bamboo forest is only found in the country's five water towers. With the foresaid not withstanding, the alternative of not cutting is a worse scenario because bamboo has very poor regeneration if left unattended. Indeed, cutting bamboo triggers prolific regeneration as evidenced along the main road at Kieni forest station (Figure 1). The compromise would be to cut slightly less than 50 % of the old and dead culms which is in agreement with results of many silvicultural studies that reducing density of a stand by half does not result in growth shock or expose the environment to harsh weather conditions.

The authors recommend that, the Kenya Forest service can use the results of this study to embrace scientific management of bamboo resources and lifting of the ban on harvesting bamboo culms. In addition, it is necessary to establish the potential of *Y. alpina* in carbon sequestration.

The practical significance of the results of this study is that if Kenya Forest service could embrace scientific management of bamboo resources in the country, the regression models presented in Tables 8 and 9 can readily be applied.

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Appendix 1. Descriptive statistics of *Yushania alpina* culms at Kieni, Kamae and Kinale forest stations

Plot No.	Statistic	Dbh, cm	Merchantable height , m	Total Height , m	Weight ,kg
1	Mean	5.578	10.022	11.511	9.578
	N	9	9	9	9
	Std. Deviation	0.741	0.896	2.337	4.297
	Minimum	4.4	9.1	6	5
	Maximum	7	11.4	14.2	19.5
	Std. Error of Mean	0.247	0.299	0.779	1.432
2	Mean	5.478	8.933	11.5	9.889
	N	9	9	9	9
	Std. Deviation	0.806	1.343	1.504	2.619
	Minimum	4.3	7.5	8.9	7
	Maximum	6.6	10.8	13.4	15
	Std. Error of Mean	0.269	0.448	0.501	0.873
3	Mean	5.611	9.378	11.4	11.289
	N	9	9	9	9
	Std. Deviation	0.395	0.624	1.393	1.159
	Minimum	4.9	8.6	9.3	9.5
	Maximum	6	10.6	13.4	13
	Std. Error of Mean	0.132	0.208	0.464	0.386
4	Mean	5.178	9.822	10.6	9.467
	N	9	9	9	9
	Std. Deviation	0.578	1.518	3.325	2.31
	Minimum	4.1	8.4	4.8	5.5
	Maximum	6	12.5	13.1	13.5
	Std. Error of Mean	0.193	0.506	1.108	0.77
5	Mean	5.444	9.356	12.022	10.222
	N	9	9	9	9
	Std. Deviation	0.48	0.697	0.784	2.451
	Minimum	4.7	8.3	10.7	7
	Maximum	6.3	10.5	13.1	14.5
	Std. Error of Mean	0.16	0.232	0.261	0.817
6	Mean	5.567	8.422	10.7	10.333
	N	9	9	9	9
	Std. Deviation	0.704	1.326	1.015	3.767
	Minimum	4.4	5.3	8.9	4
	Maximum	6.7	9.6	12	17

	Std. Error of Mean	0.235	0.442	0.338	1.256
7	Mean	5.456	7.711	10.6	8.611
	N	9	9	9	9
	Std. Deviation	0.808	0.952	1.095	3.814
	Minimum	4.7	6.4	8.7	5.5
	Maximum	7.4	9.5	12.4	17.5
	Std. Error of Mean	0.269	0.317	0.365	1.271
8	Mean	4.556	7.389	10.744	6.778
	N	9	9	9	9
	Std. Deviation	0.846	1.122	0.633	2.763
	Minimum	3.8	5.8	10.2	3.5
	Maximum	6.5	9.7	12.2	12
	Std. Error of Mean	0.282	0.374	0.211	0.921
9	Mean	5.2	8.389	11.444	7.556
	N	9	9	9	9
	Std. Deviation	0.485	0.593	0.482	1.878
	Minimum	4.6	7.8	10.6	5.5
	Maximum	6	9.5	12.3	11
	Std. Error of Mean	0.162	0.198	0.161	0.626
10	Mean	6.056	9.1	11.656	12.222
	N	9	9	9	9
	Std. Deviation	0.784	1.069	2.041	2.819
	Minimum	5	7.7	8.3	7.5
	Maximum	7	10.6	13.6	16
	Std. Error of Mean	0.261	0.356	0.68	0.94
11	Mean	4.783	6.867	8.867	7.833
	N	6	6	6	6
	Std. Deviation	0.462	0.814	1.728	1.633
	Minimum	4	5.6	6.4	6
	Maximum	5.2	7.9	10.8	10
	Std. Error of Mean	0.189	0.332	0.706	0.667
12	Mean	4.522	6.8	10.056	6.167
	N	9	9	9	9
	Std. Deviation	0.538	1.361	1.466	1.732
	Minimum	4	5.5	8.7	4.5
	Maximum	5.7	10.1	13.6	10.5
	Std. Error of Mean	0.179	0.454	0.489	0.577

13	Mean	4.878	6.6	9.867	6.667
	N	9	9	9	9
	Std. Deviation	0.277	0.606	1.124	1.173
	Minimum	4.5	5.7	8.4	5
	Maximum	5.3	7.5	12	9
	Std. Error of Mean	0.092	0.202	0.375	0.391
14	Mean	3.944	5.533	8.611	4.011
	N	9	9	9	9
	Std. Deviation	0.747	1.74	1.158	2.101
	Minimum	2.8	2.4	7.3	0.6
	Maximum	4.8	7.6	10.4	7
	Std. Error of Mean	0.249	0.58	0.386	0.7
15	Mean	4.311	5.922	9.467	6.1
	N	9	9	9	9
	Std. Deviation	0.337	0.626	0.456	1.217
	Minimum	3.9	5.2	8.6	5
	Maximum	5	7.1	10.2	8
	Std. Error of Mean	0.112	0.209	0.152	0.406
16	Mean	5.333	6.467	9.733	8.417
	N	6	6	6	6
	Std. Deviation	0.866	1.169	0.819	3.2
	Minimum	4.2	4.6	8.2	4
	Maximum	6.4	7.8	10.6	13
	Std. Error of Mean	0.354	0.477	0.334	1.307
17	Mean	4.822	9.233	10.422	8.444
	N	9	9	9	9
	Std. Deviation	0.696	2.632	1.81	3.901
	Minimum	4	6.4	6.7	5.5
	Maximum	6.4	13.7	12.6	18
	Std. Error of Mean	0.232	0.878	0.603	1.3
18	Mean	4.733	7.011	9.089	7.056
	N	9	9	9	9
	Std. Deviation	0.287	1.324	2.031	1.629
	Minimum	4.4	5.7	5.7	5.5
	Maximum	5.2	9.2	11.6	10
	Std. Error of Mean	0.096	0.441	0.677	0.543
19	Mean	5.622	7.122	10.589	9.833

	N	9	9	9	9
	Std. Deviation	0.674	1.652	1.547	2.795
	Minimum	4.7	5.1	8.1	6
	Maximum	6.7	9.8	12.3	13
	Std. Error of Mean	0.225	0.551	0.516	0.932
20	Mean	4.4	5.489	8.544	4.667
	N	9	9	9	9
	Std. Deviation	0.555	1.202	1.749	1.5
	Minimum	3.6	3.4	5.6	3
	Maximum	5	7.1	10.8	7
	Std. Error of Mean	0.185	0.401	0.583	0.5
21	Mean	5.9	9.3	11.922	10.856
	N	9	9	9	9
	Std. Deviation	0.557	1.395	1.461	2.267
	Minimum	4.8	6.3	8.8	7
	Maximum	6.6	11	13.9	15
	Std. Error of Mean	0.186	0.465	0.487	0.756
22	Mean	5.878	9.844	11.967	11.444
	N	9	9	9	9
	Std. Deviation	0.502	1.736	0.918	2.567
	Minimum	4.8	7.2	10.6	6
	Maximum	6.6	13.5	13.4	14.5
	Std. Error of Mean	0.167	0.579	0.306	0.856
23	Mean	5.911	9.167	11.844	11.167
	N	9	9	9	9
	Std. Deviation	0.431	0.907	1.352	2.947
	Minimum	5.5	8.1	9.7	8
	Maximum	6.6	11	14	16.5
	Std. Error of Mean	0.144	0.302	0.451	0.982
24	Mean	6.133	10.244	12.467	13.678
	N	9	9	9	9
	Std. Deviation	0.406	0.899	1.124	1.58
	Minimum	5.3	8.9	10.2	12
	Maximum	6.6	11.4	14	16
	Std. Error of Mean	0.135	0.3	0.375	0.527
25	Mean	6.178	10.667	13.122	12.767
	N	9	9	9	9

	Std. Deviation	0.396	0.97	0.889	2.463
	Minimum	5.4	8.3	11.1	9
	Maximum	6.7	11.6	14	16.5
	Std. Error of Mean	0.132	0.323	0.296	0.821