

Appendix

APPENDIX 1
Randomly collected samples

S. No.	Length (mm)	Major (mm)	Minor Dia (mm)	Full wt of nut (g)	Shell wt	Final wt of copra	Wt of water	Wt of fresh kernel	Shell thickness	Geometric mean diameter (mm)	Sphericity	Surface area (cm ²)
1	81.95	72.74	71.53	174	64	64	0	110	3.26	75.267	0.918	177.8839
2	87.81	72.27	71.81	193	70	70	2	121	3.42	76.954	0.876	185.9463
3	83.36	79.88	76.15	239	76	93	18	145	4.02	79.742	0.957	199.6672
4	75.16	81.72	80.45	243	76	86	25	142	4.03	79.058	1.052	196.2564
5	88.2	75.17	74.61	248	64	80	44	140	2.9	79.087	0.897	196.3977
6	92.92	78.08	77.35	260	81	84	28	151	3.78	82.484	0.888	213.6334
7	88.69	78.78	77.33	260	77	87	27	156	2.9	81.448	0.918	208.2997
8	80.42	81.76	78.33	261	72	62	55	134	4.24	80.158	0.997	201.7522
9	87.78	77.69	77.33	263	77	76	56	130	2.62	80.792	0.920	204.9598
10	91.65	85.95	75.84	268	81	86	26	161	2.97	84.222	0.919	222.7311
11	88.09	78.63	76.7	270	103	88	18	149	4.53	80.991	0.919	205.9696
12	104.08	79.35	79.32	276	90	107	16	170	3.38	86.849	0.834	236.8432
13	86.92	83.2	79.71	278	81	99	42	155	4.05	83.225	0.957	217.4871
14	92.11	81.89	81.19	281	86	92	25	170	4.25	84.921	0.922	226.4417
15	94.11	82.5	81.35	288	88	86	18	182	4.18	85.799	0.912	231.1503
16	98.66	78.09	76.43	288	80	104	50	158	3.19	83.817	0.850	220.5955
17	99.72	92.07	89.96	303	86	115	39	178	3.44	93.825	0.941	276.4158
18	85.37	82.22	81.94	305	97	93	46	162	4.22	83.162	0.974	217.1611
19	91.7	88.32	83.36	307	97	104	21	189	2.82	87.726	0.957	241.6501
20	102.25	81.01	76.87	313	88	105	38	187	3.15	86.031	0.841	232.3997
21	103.69	78.58	77.47	319	90	102	50	179	3.63	85.782	0.827	231.0564
22	91.28	83.18	82.77	329	91	93	54	184	4.18	85.656	0.938	230.3782
23	87.69	86.89	84.07	330	81	97	73	176	2.86	86.203	0.983	233.3298
24	98.14	86.88	86.63	330	104	105	38	188	2.82	90.395	0.921	256.5778
25	101.98	79.95	79.93	339	89	96	75	175	3.11	86.699	0.850	236.0253
26	96.04	89.17	88.26	344	109	139	24	211	3.68	91.092	0.948	260.5471
27	95.28	87.12	84.14	347	105	89	65	177	3.65	88.724	0.931	247.1787
28	96.74	87.94	86.89	353	96	90	68	189	2.75	90.418	0.935	256.7071
29	99.62	89.81	88.19	353	108	143	25	220	4.4	92.405	0.928	268.1164
30	95.47	84.34	80.71	354	115	115	62	177	4.63	86.618	0.907	235.5853
31	92.33	87.07	86.92	357	96	103	61	200	3.51	88.738	0.961	247.2580
32	86.04	87.41	86.25	361	123	108	63	175	2.7	86.565	1.006	235.2936

S. No.	Length (mm)	Major (mm)	Minor Dia (mm)	Full wt of nut (g)	Shell wt	Final wt of copra	Wt of water	Wt of fresh kernel	Shell thickness	Geometric mean diameter (mm)	Sphericity	Surface area (cm ²)
33	103.95	82.44	82.27	361	98	118	73	190	3.21	89.002	0.856	248.7324
34	94.31	89.16	87.76	379	113	112	53	213	3.24	90.367	0.958	256.4165
35	99.09	90.54	89.2	395	110	102	79	206	2.7	92.842	0.937	270.6573
36	103.05	84.51	83.95	396	118	126	80	198	3.32	90.086	0.874	254.8282
37	105.91	92.18	88.27	396	105	131	59	232	3	95.162	0.899	284.3506
38	105.92	82.37	82.16	398	106	135	94	198	3.58	89.496	0.845	251.4981
39	92.04	93.33	90.95	399	116	116	70	213	3.47	92.102	1.001	266.3565
40	105.93	90.79	88.8	402	122	144	49	231	4.44	94.876	0.896	282.6461
41	103.01	88.57	88.43	405	124	120	51	230	3.45	93.094	0.904	272.1281
42	93.26	91.74	91.3	411	100	148	102	209	4.35	92.096	0.988	266.3256
43	104.64	86.81	86.43	416	110	112	85	221	4.64	92.252	0.882	267.2294
44	93.08	98.99	97.36	416	138	126	45	233	6.5	96.444	1.036	292.0666
45	98.99	97.99	94.77	419	136	140	41	242	3.18	97.233	0.982	296.8650
46	97.84	97.28	93.66	424	142	116	59	223	4.38	96.242	0.984	290.8433
47	100.02	92.6	89.83	425	126	136	75	224	6	94.053	0.940	277.7639
48	104.89	89.6	88.75	425	115	158	68	242	3.91	94.132	0.897	278.2296
49	107.03	92.34	91.31	428	122	140	58	248	4.15	96.636	0.903	293.2280
50	104.3	89.22	88.4	431	126	125	89	216	3.68	93.699	0.898	275.6738
51	101.23	90.04	89.97	432	114	140	99	219	3.31	93.601	0.925	275.1004
52	95.9	94.31	91.98	436	120	108	103	213	4.2	94.050	0.981	277.7428
53	117.92	89.96	87.54	445	131	128	89	225	4.04	97.562	0.827	298.8766
54	95.66	94.88	92.3	453	127	118	92	234	3.76	94.269	0.985	279.0407
55	104.91	91	90.35	453	130	144	79	244	3.75	95.191	0.907	284.5251
56	100.79	90.71	89.86	459	116	132	133	210	2.44	93.658	0.929	275.4370
57	111.46	91.85	90.45	464	150	120	69	245	3.98	97.470	0.874	298.3098
58	104.21	93.83	93.57	464	127	137	89	248	3.9	97.080	0.932	295.9294
59	5.01	89.24	85.43	465	136	158	72	257	5.01	33.677	6.722	35.6124
60	98.4	98.51	97.19	471	140	124	87	244	3.75	98.032	0.996	301.7595
61	107.64	92.31	90.02	473	167	132	95	211	3.42	96.350	0.895	291.4991
62	111.69	92.3	90.23	473	162	143	87	224	3.9	97.616	0.874	299.2087
63	102.98	95.19	92.62	478	141	137	89	248	5.19	96.831	0.940	294.4166
64	113.36	89.85	89.27	482	133	127	130	219	3.63	96.879	0.855	294.7035
65	95.83	99.74	96.08	484	141	128	85	258	4.8	97.200	1.014	296.6645
66	105.64	91.74	87.42	485	127	110	90	268	4.3	94.624	0.896	281.1436
67	101.73	96.17	95.45	486	123	140	101	262	3.91	97.744	0.961	299.9895
68	107.6	95.22	91.12	488	152	147	94	242	3.04	97.735	0.908	299.9386

S. No.	Length (mm)	Major (mm)	Minor Dia (mm)	Full wt of nut (g)	Shell wt	Final wt of copra	Wt of water	Wt of fresh kernel	Shell thickness	Geometric mean diameter (mm)	Sphericity	Surface area (cm ²)
69	110.39	92.32	90.59	490	142	165	85	263	4.49	97.372	0.882	297.7146
70	97.57	98.7	95.39	492	132	143	108	252	3.62	97.210	0.996	296.7248
71	88.92	101.21	95.64	494	118	133	151	225	2.95	95.123	1.070	284.1218
72	103.61	96.9	96.38	497	128	136	116	253	4.62	98.909	0.955	307.1882
73	116.65	89.68	87.74	499	145	147	108	246	3.78	97.184	0.833	296.5616
74	109.38	96.72	93.64	501	128	109	96	277	3.66	99.687	0.911	312.0375
75	113.47	100.06	99.57	505	137	108	92	276	3.5	104.17	0.918	340.7556
76	120.96	90.44	87.96	507	140	160	113	254	4.15	98.725	0.816	306.0469
77	101.23	99.79	97.93	508	147	148	104	257	3.55	99.641	0.984	311.7485
78	95.75	102.26	98.97	518	135	134	119	264	3.51	98.958	1.034	307.4882
79	103.11	98.1	96.08	518	132	146	139	247	2.6	99.053	0.961	308.0809
80	104.7	99.55	97.77	525	130	103	131	264	3.26	100.63	0.961	317.9743
81	118.29	95.23	91.68	525	144	173	96	285	4.05	101.08	0.855	320.8194
82	103.23	99.29	98.73	530	144	146	120	266	3.68	100.39	0.973	316.4973
83	103.55	100.99	97.91	541	127	160	135	279	4.03	100.79	0.973	318.9824
84	107.9	95.79	90.4	544	136	147	148	260	3.92	97.762	0.906	300.1025
85	114.67	95.99	93.8	559	146	160	158	255	4.05	101.07	0.881	320.7614
86	112.35	95.84	93.36	560	152	161	144	264	3.85	100.17	0.892	315.1013
87	105.33	97.6	97.31	561	138	169	154	269	4	100.01	0.950	314.0768
88	98.41	105.97	104.25	584	163	144	114	307	3.54	102.82	1.045	331.9926
89	113.97	96.6	94.12	584	155	176	136	293	3.68	101.19	0.888	321.5358
90	108.96	102.13	98.03	605	146	136	174	285	4.03	102.94	0.945	332.7484
91	96.21	104.4	101.6	609	125	147	168	316	5.17	100.67	1.046	318.2775
92	105.51	106.63	105.4	650	156	194	160	334	4.38	105.84	1.003	351.7808
93	109.64	104.67	104.48	656	140	162	168	348	3.96	106.23	0.969	354.3882
94	120.41	101.91	97.49	672	157	184	201	314	3.46	106.15	0.882	353.8528
95	93.49	111.19	110.23	674	157	151	209	308	3.55	104.64	1.119	343.8350
96	99.98	117.45	113.61	700	134	146	219	347	3.85	110.08	1.101	380.5264
97	112.46	106.99	105.67	703	173	201	186	344	4.48	108.33	0.963	368.5177
98	93.33	117.25	114.35	726	134	132	249	343	5.46	107.76	1.155	364.6223

Samples collected to study the variability of dehusked coconut of size 80-90mm

Group	Wt of nut	Major dia	Minor dia	Length	Wt of shell	Thickness of the shell	Wt of copra	Wt of fresh kernel	Wt of water	Thickness of kernel	Spericity
A	269	86.64	84.04	85.71	87	3.85	88	168	14	9.54	0.997043
A	285	84.5	83.55	82.76	73	2.2	68	158	54	9.5	1.010154
A	302	87.65	85.31	88.68	106	3.48	100	154	42	9.57	0.983332
A	307	84.91	84.27	94.51	102	3.83	90	172	33	7.97	0.928736
A	308	85.37	84.55	98.59	106	3.86	100	178	24	10.84	0.905561
A	319	82.3	79.17	99.26	96	3.56	109	178	45	11.46	0.871239
A	319	86.89	86.02	97.69	93	2.41	126	200	26	12.22	0.921771
A	330	81.77	81.39	98.39	107	3.9	101	184	39	11.22	0.882581
A	330	85.41	83.39	106.94	116	3.1	94	194	20	11.72	0.853979
A	332	85.98	75.22	97.31	103	3.8	110	190	39	12.35	0.880654
A	344	84.58	84.37	89	105	3.25	88	185	54	10.96	0.96581
A	355	85.72	84.64	93.6	98	3.04	127	205	52	14.21	0.939079
A	357	85.81	83.32	97.98	118	3.88	116	205	34	11.77	0.906437
A	357	89.77	85.98	98.51	103	2.7	126	209	45	10.85	0.926523
A	361	82.75	80.98	110.3	117	3.88	121	204	40	10.72	0.819719
A	361	83.81	82.1	107.34	105	2.48	121	234	22	12.61	0.842116
A	361	84.36	83.19	102.54	107	4.04	118	204	50	11.12	0.873924
A	364	85.2	82.75	103.39	127	4.32	118	201	36	10.38	0.870463
A	368	87.44	85.06	106.4	125	3.9	125	209	34	12.4	0.869329
A	368	89.22	83.71	107.57	117	3.7	121	210	41	11.42	0.86421
A	368	90.25	88.51	99.23	118	3.7	116	202	48	11.23	0.932648
A	369	85.63	82.27	100.45	108	3.56	134	220	41	12.74	0.887134
A	369	86.69	85.89	96.17	134	3.65	107	195	40	14.65	0.930274
A	370	85.59	85	101.9	107	3.14	125	220	43	12.47	0.888174
A	371	90.81	87.24	103.37	116	2.9	115	220	35	12.81	0.90508

Group	Wt of nut	Major dia	Minor dia	Length	Wt of shell	Thickness of the shell	Wt of copra	Wt of fresh kernel	Wt of water	Thickness of kernel	Spericity
A	375	87.06	85.25	106.88	104	2.9	124	211	60	11.4	0.866111
A	379	88.99	87.22	93.67	103	3.2	119	199	77	11.25	0.959958
A	380	87.74	86.66	95.67	132	3.7	108	186	62	9.8	0.940059
A	381	85.14	84.03	99	124	3.84	128	187	70	11.86	0.900394
A	381	89.68	87.89	91.22	110	4.14	125	210	61	11.9	0.982091
A	382	81.63	79.18	116.08	124	4.15	137	222	36	12.57	0.782799
A	382	85.43	81.83	110.65	149	4.8	119	204	29	9.86	0.829609
A	384	83.56	82.43	116.18	119	2.69	135	216	49	11.89	0.799111
A	386	87.92	83.63	103.26	134	4.38	127	214	38	10.17	0.883477
A	389	82.84	81.64	112.3	126	3.9	130	215	48	11.58	0.812446
A	390	88.91	86.81	97.45	93	2.63	121	211	86	12.47	0.933223
A	394	87.37	85.32	97.86	123	3.55	112	198	73	10.71	0.919887
A	396	88	86.09	107.47	136	3.85	128	229	31	13.55	0.868868
A	398	83.56	81.74	111.03	121	3.6	127	202	75	11.62	0.82133
B	400	88.3	86.88	104.57	110	3.32	119	222	68	9.99	0.888564
B	401	86.19	84.6	110.72	141	4.6	137	230	30	11.66	0.840992
B	401	89.81	88.94	104.35	125	2.74	145	239	37	13.26	0.901874
B	403	83.91	83.73	109.7	112	2.87	125	233	58	14.03	0.835784
B	404	86.27	84.93	103.37	99	3.56	131	231	74	11.76	0.881815
B	406	87.24	86.96	106.71	120	3.53	140	231	55	11.65	0.87339
B	407	86.8	85.51	112.58	123	4.38	149	227	57	10.76	0.836639
B	409	88.91	87.37	101.21	95	2.42	143	242	72	12.98	0.911917
B	410	83.6	83.45	115.4	118	3.85	118	210	82	10.19	0.806134
B	410	85.15	82.48	120.91	134	3.41	156	243	33	13.47	0.783194
B	412	80.7	77.64	116.33	140	4.38	128	200	72	11.18	0.773616
B	415	84.53	83.57	114.28	132	4.18	136	230	53	11.63	0.81478

Group	Wt of nut	Major dia	Minor dia	Length	Wt of shell	Thickness of the shell	Wt of copra	Wt of fresh kernel	Wt of water	Thickness of kernel	Spericity
B	415	85.97	84.42	117.36	124	3.78	147	227	64	12.22	0.807701
B	415	87.76	83.92	107.33	125	2.96	133	207	83	11.27	0.86147
B	416	87.24	86.7	101.48	106	3.08	118	219	91	9.87	0.902245
B	416	88.1	86.37	100.36	114	2.9	137	227	75	15.12	0.910764
B	418	88.05	86.78	101.21	106	3.5	125	231	81	12.05	0.906917
B	420	87.97	86.96	97.72	129	3.22	120	217	74	13	0.928743
B	421	87.84	84.2	101.92	135	3.6	125	204	82	11.5	0.892953
B	423	87.36	84.34	113.28	103	2.95	142	237	83	12.45	0.831151
B	428	86.98	86.46	101.2	112	4.23	139	232	84	11.73	0.902176
B	432	89.53	85.93	106.58	108	3	114	233	91	11.46	0.878188
B	440	89.29	88.57	113.49	133	4	119	233	74	11.5	0.849946
B	441	89.41	88.97	115	115	3.75	139	266	60	14.03	0.844134
B	445	94.38	90.63	107.45	146	3.85	107	244	55	11.1	0.904856
B	448	88.24	87.61	114.73	138	3.75	164	269	41	12.39	0.837443
B	452	88.49	87.37	106.23	115	3.14	145	247	90	11.04	0.881564

Samples collected to study the variability of dehusked coconut of size 90-100 mm

Group	wt of nut	major dia	minor dia	length	wt of shell	thickness of the shell	wt of copra	wt of fresh kernel	wt of water	thickness of kernel	Spericity
A	350	92.43	88.88	102.35	122	3.96	104	207	21	10.19	0.922
A	370	89.76	88.99	100.5	113	3.8	107	231	26	11.45	0.925
A	380	91.87	88.2	89.12	119	4.04	95	194	67	9.31	1.007
A	390	89.75	86.02	101.59	123	3.08	116	209	58	11.63	0.908
A	395	89.37	87.86	99.41	83	2.48	102	222	90	10.56	0.926
A	397	90.67	87.12	94.53	114	3.52	124	221	62	12.79	0.960
B	400	94.08	93.29	107.08	94	3.13	139	253	53	11.6	0.915
B	407	91.87	87.83	95.63	125	3.64	130	227	55	12.7	0.959
B	409	89.93	89.59	94.96	122	3	107	224	63	12.85	0.963
B	418	94.65	90.69	96.93	125	3.93	138	240	53	13.75	0.970
B	422	91.7	90.27	91.09	110	3.56	118	223	89	11.89	0.999
B	422	93.28	91.75	97.49	128	3.6	106	216	78	10.3	0.966
B	423	89.97	86.4	105.08	126	4.12	112	239	58	12.2	0.890
B	424	90.18	87.36	103.97	109	2.55	142	238	77	13.1	0.900
B	426	90.48	86.6	105.39	110	2.63	131	257	59	13.6	0.890
B	436	91.29	89.47	107.9	126	5.14	114	259	51	11.66	0.889
B	437	94.5	89.24	98.28	130	4.1	117	202	105	10.4	0.956
B	437	96.69	95.74	90.24	118	3.05	123	226	93	11.21	1.044
B	439	92.96	91.12	99.46	130	4.46	149	253	56	12.09	0.950
B	439	94.56	92.51	100.14	116	3.56	121	251	72	12.65	0.955
B	439	96.22	94.36	99.37	123	3.26	111	218	98	10.3	0.972
B	442	90.87	89.32	104.16	132	4.35	158	252	58	12.33	0.908
B	444	89.91	88.28	104.49	128	3.42	143	237	79	11.88	0.899
B	447	92.2	86.18	108.03	109	4.3	126	244	94	11.65	0.880
B	449	92.35	91.66	102.01	109	3.25	137	241	99	13.24	0.933
B	450	94.35	93.86	98.33	113	3.73	120	236	101	11.22	0.971
B	456	89.73	87.15	114.09	144	3.16	126	240	72	13.18	0.844

Group	wt of nut	major dia	minor dia	length	wt of shell	thickness of the shell	wt of copra	wt of fresh kernel	wt of water	thickness of kernel	Spericity
B	458	93.63	93.09	95.53	121	3.35	150	250	87	11.4	0.985
B	458	94.94	93.32	117.55	172	4.34	160	271	15	12.52	0.862
B	460	91.93	90.21	98.82	118	3.74	125	240	102	11.55	0.947
B	461	95.69	94.94	97.45	142	4.09	119	229	90	11.05	0.985
B	461	97.06	95.41	101.48	179	4.41	148	194	88	14.44	0.965
B	462	93.64	92.1	106.94	132	4	115	243	87	10.52	0.910
B	467	92.79	91.45	105.04	121	4.35	147	245	101	11.8	0.916
B	467	94.55	92.01	102.53	124	3.38	153	261	82	12.2	0.939
B	469	95.59	88.26	108.64	142	3.68	124	264	63	12.57	0.894
B	470	96.52	94.3	97.16	140	3.7	119	241	89	11.65	0.988
B	473	89.84	89.06	108.45	137	3.1	140	255	81	12	0.879
B	474	94.27	91.46	104.25	137	3.08	110	242	95	12.87	0.926
B	475	91.31	90.2	108.02	129	3.44	140	257	89	13.96	0.890
B	477	93.77	93.73	95.83	167	4.92	139	236	74	12.4	0.985
B	479	96.44	94.13	95.37	131	4.1	121	255	93	11.1	0.999
B	482	90.69	89.72	113.18	162	4.85	149	256	64	11.6	0.860
B	488	91.15	89.39	116.78	121	4.1	159	275	92	11.95	0.842
B	488	95.55	93.07	109.31	125	4.12	153	258	105	10.38	0.906
B	489	92.29	90.95	103.63	142	4.46	146	246	101	11.96	0.921
B	491	93.19	93.16	107.23	138	3.86	132	265	88	11.38	0.911
B	492	91.1	91	109.03	152	4	136	250	90	12.25	0.887
B	492	93.78	88.87	111.51	130	4.21	117	256	106	11.47	0.875
B	492	94.28	92.73	107.32	126	3.2	111	256	110	12.7	0.912
B	495	98.16	97.67	101.33	140	4.75	147	281	74	11.83	0.977
B	496	94.42	91.93	101.75	121	3.3	140	237	138	12.3	0.943
B	497	94.72	91.23	110.57	138	3.65	126	242	117	11.5	0.891
B	497	95.64	94.1	107.63	161	4.1	149	254	82	11.44	0.919
B	499	93.62	89.76	118.95	158	4.55	136	296	45	13.4	0.841

Group	wt of nut	major dia	minor dia	length	wt of shell	thickness of the shell	wt of copra	wt of fresh kernel	wt of water	thickness of kernel	Spericity
C	502	89.13	88.6	117.99	154	4.29	145	269	79	10.95	0.828
C	503	95.8	94.39	107.78	153	3.53	146	263	87	12.42	0.920
C	504	96.46	94.63	106.35	148	4.04	141	262	94	12.77	0.931
C	507	96.98	96.23	106.66	139	4.24	160	260	108	11.22	0.936
C	511	95.96	95.92	100.33	124	2.86	116	267	120	13.49	0.971
C	511	99.13	96.05	100.44	118	2.95	172	272	121	12.83	0.981
C	514	97.62	97.33	100.68	131	3.75	133	265	118	11.75	0.979
C	515	92.99	91.9	106.48	136	3.63	150	266	113	11.63	0.910
C	516	93.22	91.16	104.42	152	4.24	138	248	116	11.16	0.920
C	525	97.85	97.41	105.66	146	3.55	116	273	106	11.11	0.949
C	533	96.84	96.53	115.56	125	3.86	153	292	116	11	0.888
C	547	99.6	99.18	104.6	137	3.12	158	282	128	12.43	0.967
C	559	93.76	92.2	112.94	156	4.75	164	277	126	12.55	0.878
C	559	98.94	97.64	119.4	156	3.48	158	284	119	12.07	0.878
C	560	96.03	93.73	108.87	148	3.58	160	274	138	11.65	0.912
C	567	99.62	95.66	103.31	147	3.75	127	270	150	10.36	0.963
C	568	98.01	97.14	109.6	155	4	152	287	126	11.8	0.925
C	587	96.02	93.52	117.82	139	2.74	188	325	123	14.57	0.865
C	590	99.7	98.47	112.04	146	3.12	143	290	154	11.43	0.921
C	597	100.13	99.39	105.98	156	3.82	159	277	164	12.14	0.960
C	627	99.44	98.9	103.88	168	4	139	303	156	15.75	0.970

Samples collected to study the variability of dehusked coconut of size 100-110 mm

Group	full wt of nut	major dia	minor dia	length	wt of shell	thickness of the shell	Final wt of copra	wt of fresh kernel	wt of water	thickness of kernel	spericity
A	505	100.11	99.62	111.98	137	3.5	193	319	49	14.2	0.927
A	518	99.88	96.45	102.02	113	3.21	136	314	91	13.17	0.975
A	536	101.52	100.52	114.28	194	4.43	193	298	44	12.62	0.921
A	542	99.62	97.12	103.62	156	3.9	143	274	112	11.55	0.966
A	550	101.62	98.07	100.46	149	3.35	131	256	145	11.07	0.996
A	555	104.26	100.47	107.28	146	3.62	129	281	128	11.12	0.969
A	555	105.37	104.06	105.43	155	3.63	159	288	112	11.5	0.995
A	563	102.03	99.14	102.97	124	3.7	144	265	174	12.3	0.984
A	564	99.25	97.3	105.23	130	2.86	168	288	146	13.54	0.955
A	571	100.58	96.18	113.45	158	4.12	132	264	149	10.93	0.909
A	573	100.64	99.2	100.03	154	4	173	293	126	12.7	0.999
A	585	103.15	102.21	103.73	158	3.18	181	284	143	13.17	0.993
A	586	103.35	101.07	109.17	175	3.66	98	298	113	12.69	0.957
A	588	102.58	99.81	108.22	133	3	141	270	185	11.65	0.956
A	592	103.49	101.67	105.79	178	4.56	154	295	119	12.19	0.980
A	597	101.65	101.59	103.02	153	3.86	119	291	153	11.62	0.991
A	598	102.86	102.28	106.65	149	4.66	148	283	166	9.74	0.974
B	604	101.06	94.49	118.17	157	3.53	167	299	148	11.57	0.881
B	605	102.14	100.28	116.98	143	3.35	168	331	131	12.35	0.908
B	607	102.59	101.47	103.8	138	3.81	159	312	157	10.84	0.989
B	608	102.37	100.46	107.22	149	2.5	205	350	109	17.5	0.964
B	608	105.1	102.37	105.91	166	4.02	133	266	176	10.58	0.986
B	611	99.56	96.25	108.5	168	3.92	143	279	164	12.18	0.934
B	613	104.47	101.2	114.85	181	3.5	168	301	131	10.75	0.929
B	614	100.22	99.56	118.71	144	3.4	148	318	152	11.15	0.891
B	617	101.24	99.59	110.48	165	3.54	169	300	152	11.76	0.938
B	617	101.56	99.58	109.74	167	3.55	165	304	146	12.95	0.943
B	619	100.24	100.22	101.43	170	4.12	132	274	175	11.05	0.992
B	619	101.57	99.97	107.12	160	3.4	158	317	142	12.81	0.960

Group	full wt of nut	major dia	minor dia	length	wt of shell	thickness of the shell	Final wt of copra	wt of fresh kernel	wt of water	thickness of kernel	spericity
B	623	102.85	101.04	117.75	159	3.28	176	324	140	11.17	0.908
B	626	101.75	101.23	109.02	169	3.9	154	289	168	11.8	0.953
B	628	106.82	103.4	107.02	158	3.35	191	320	150	11.91	0.988
B	636	106.4	105.48	106.65	138	3.8	162	300	198	11.7	0.996
B	639	106.48	105.78	109.66	174	3.45	137	265	200	10.57	0.978
B	647	103.79	100.2	109.05	150	3.7	205	349	148	14.55	0.956
B	659	105.64	105.61	108.96	188	4.36	160	284	187	9.98	0.979
B	661	99.84	98.39	113.61	191	4.72	195	335	135	12.88	0.913
B	661	100.3	97.89	119.17	153	2.9	176	324	184	12.05	0.884
B	664	99	98.44	115.85	158	3.85	200	330	176	12.77	0.899
B	666	106.63	104.41	111.33	185	3.75	140	277	204	11.15	0.965
B	671	106.85	105.4	108.46	174	3.76	169	323	174	11.09	0.986
B	675	105.07	102.44	105.46	200	4.42	156	328	147	13.74	0.989
B	683	106.6	106.49	118.99	170	3.14	228	398	115	14.82	0.929
B	684	107.77	104.66	109.72	146	2.65	188	356	182	12.17	0.979
B	689	103.3	99.05	124.05	162	3.7	151	327	200	11.65	0.873
C	694	106.51	103.97	111.92	150	3.3	202	359	185	11.9	0.960
C	711	104.41	102.94	114.99	184	3.42	183	345	182	13.68	0.933
C	712	107.67	103.6	114.83	170	2.95	212	368	174	14.09	0.946
C	719	103.94	103.41	116.49	185	3.7	161	326	208	12.68	0.925
C	743	103.67	102.37	122.56	165	3.25	210	390	188	14.2	0.891
C	743	105.13	103.08	116.7	160	3.1	162	364	219	13.6	0.927
C	748	103.78	102.98	115.46	221	4.31	152	334	193	10.99	0.929

APPENDIX II

1. Specification of load cell

1	Rated output (mv/v)	1.994
2	Non –linearity(%F.S)	0.010
3	Hysteresis% (F.S)	0.017
4	Repeatability (%F.S)	0.011
5	Creep (%F.S/30min)	0.019
6	Temp. effect on span (%F.S/10C)	0.020
7	Temp. effect on span (%F.S/10C)	0.017
8	Zero balance (%F.S)	±1.5
9	Input impedance (Ω)	402±10
10	Output impedance (Ω)	350±5
11	Insulation resistance (M Ω)	≥50VDC
12	Recommended excitation voltage (VDC)	9
13	Allowed excitation voltage (VDC)	5
14	Compensated temp. range (C)	-10C
15	Operating temp. range (C)	-20C
16	Safe overload (%F.S)	120
17	Ultimate overload (%F.S)	150

2. Algorithm for the development of software program

Step 1: Create library for LCD display and serial communication

Step 2: Define macros for the keypad and solenoids relay

Step 3: Initialize variables required for the process

Step 4: Define and declare load cell and keypad function

Step 5: Set the port I/O pin

Step 6: Switch off all the relay, and weight for the load cell driver to respond

Step 7: Check the EEPROM whether the values are stored using keypad, if not, then initialize it to default values 200 as high weight and 200 as low weight, threshold values

Step 8: Switch ON the relay

Step 9: When the proximity sensor is not sensed and if the “SET” key or the “MOV” key is pressed go to the settings option.

Step 10 (a): If the “SET” key is pressed then the high and low threshold weight values are stored

Step 10 (b): If the “MOV” key is pressed then the delay time for positioning after sensor sensed and the delay for weight measurement are entered and stored.

Step 11: When the proximity is sensed, relay will be stopped after the delay time.

Step 12: Weight measured after the delay time

Step 13 (a): If the weight is greater than the high value then the weight of current plate is noted as “Position 4”

Step 13 (b): If the weight is between the high and low values then it is noted as “Position 3”

Step 13 (c): If the weight is lesser than low value then it is noted as “Position 2”

Step 14: Then the controller checks the position of every plate

Step 15: When the plate reaches the location the controller ejects the coconut with the use of solenoid.

Step 16: Repeat the steps from 11 to 16.

APPENDIX III

1) Grading efficiency of fully dehusked coconut in developed size grader

Sizing belt velocity	Inclination angle	r1	r2	r3
120	10	70	68	72
120	15	76	79	73
120	20	64	60	68
140	10	80	76	79
140	15	82	80	82
140	20	73	75	75
160	10	81	78	84
160	15	85	83	87
160	20	79	77	76
180	10	70	65	68
180	15	73	70	73
180	20	68	67	73
200	10	63	65	60
200	15	63	59	60
200	20	59	50	58

2) Contamination ratio of fully dehusked coconut in developed size grader

Sizing belt velocity	Inclination angle	r1	r2	r3
120	10	36	35	32
120	15	29	30	31
120	20	33	36	37
140	10	26	29	27
140	15	29	31	26
140	20	31	37	33
160	10	29	31	25
160	15	24	28	24
160	20	31	32	25
180	10	33	38	36
180	15	32	34	30
180	20	37	45	39
200	10	38	41	43
200	15	34	40	40
200	20	45	40	41

3) Grading efficiency of partially dehusked coconut in developed size grader

Sizing belt velocity	Inclination angle	r1	r2	r3
120	10	58.4	59.1	59.4
120	15	61.9	62.5	60.3
120	20	58.6	61.0	62.0
140	10	68.6	70.7	69.2
140	15	79.8	77.0	75.8
140	20	72.3	73.8	68.7
160	10	70.2	68.2	71.0
160	15	69.7	70.9	70.1
160	20	61.2	62.6	57.7
180	10	55.1	52.7	51.8
180	15	55.9	53.4	57.0
180	20	61.5	64.3	60.4
200	10	45.6	46.2	43.9
200	15	51.0	51.5	49.8
200	20	49.9	49.4	48.0

4) Contamination ratio of fully dehusked coconut in developed size grader

Sizing belt velocity	Inclination angle	r1	r2	r3
120	10	40	35	34
120	15	29	35	27
120	20	31	35	25
140	10	31	31	31
140	15	28	26	27
140	20	29	29	29
160	10	32	33	31
160	15	26	24	25
160	20	30	29	28
180	10	35	35	35
180	15	38	39	40
180	20	39	40	38
200	10	50	52	51
200	15	49	51	50
200	20	40	39	41

5) Free falling behaviour of coconut with different treatments

Tilting angle	Carrier cup	r1	r2	r3
5	C1	20	20	30
5	C2	50	70	60
10	C1	60	60	60
10	C2	100	100	100
15	C1	80	100	90
15	C2	100	100	100

6) Carrier cup return mechanism with different treatments

Tilting angle	Carrier cup	r1	r2	r3
5	C1	100	100	100
5	C2	100	100	100
10	C1	70	80	60
10	C2	100	100	100
15	C1	50	40	30
15	C2	60	50	70

7) Grading efficiency of developed weight grader

Angular velocity (rad/min)	Settling time	r1	r2	r3
12	2	56.8	59.2	54.25
12	3	59.2	65.23	54.56
12	4	69.6	71.23	66.95
12	5	70	72	69
14	2	54.3	70.2	64.25
14	3	71.1	71.56	71.33
14	4	67.92	78.33	79.33
14	5	75	78	76
16	2	69.5	72.5	71.2
16	3	80.2	82.3	79.23
16	4	83.45	85.56	84.69
16	5	82	79	86

8) Contamination ratio of developed size grader

Angular velocity (rad/min)	Settling time	r1	r2	r3
12	2	42.3	40	46.2
12	3	40	39.33	42.5
12	4	35	30	32
12	5	28	30	32
14	2	38.33	34	43.5
14	3	28.33	33.33	32.3
14	4	24.66	31.06	25.033
14	5	25	25	27
16	2	32	28	30
16	3	21.33	25.33	23.33
16	4	10.23	14.3	25.3
16	5	20	18	18

APPENDIX IV

COST ECONOMICS OF SIZE GRADER

Assumptions made

1. Useful life of the machine (n) = 10 years
2. Interest on machine cost per year (i) = 12 %
3. Capacity of the machine = 3500 nuts/h
4. Cost of the size grader = Rs. 45,000/-
(worked out based on materials used and fabrication cost involved)
5. Number of working h/yr = 1440 (180 working days x 8 h/day)
6. Tax, insurance and shelter charge per year = 5 %
7. Repair and maintenance = 10 %

1. Fixed cost per year

$$\begin{aligned} \text{i) Fixed cost of the unit (C)} &= \frac{i(i+1)^n}{(i+1)^n - 1} \times C \\ &= \frac{0.12(0.12+1)^{10}}{(0.12+1)^{10} - 1} \times 45,000 \\ &= \text{Rs. } 7952.49/\text{year} \end{aligned}$$

$$\begin{aligned} \text{ii) Tax, insurance and shelter} &= (45,000 \times 5)/100 \\ &= \text{Rs. } 2250/\text{year} \end{aligned}$$

Total fixed cost = (i)+(ii)

$$\begin{aligned} &= 7952.49 + 2250 \\ &= 10202.49/\text{year} \end{aligned}$$

$$\begin{aligned} \text{Total fixed cost/h for annual use of 1440 hour per year} &= 10202.49/1440 \\ &= 7.08/\text{h} \end{aligned}$$

2. Variable cost of the machine

(i) Labour cost @ Rs. 450 / day of 8 hours = 450 / 8
= Rs. 56.25 / h

(ii) Repair and maintenance charges = $(45,000 \times 10) / (100 \times 1440)$
= 3.125/h

(iii) Cost of electricity

Power required to operate the unit = 1 hp (0.736 kW)

Electricity charge @ Rs. 10/ unit = $(10 \times 0.736) = \text{Rs. } 7.36/\text{h}$

Total variable cost = (i) + (ii)
= 66.73/h

Total operation cost of the machine = (1) + (2)
= **73.81/ h**

The capacity of the machine = 3500 nuts/h

Cost of operation per nut = 73.81/3500
= **Re.0.02/ nut**

COST ECONOMICS OF WEIGHT GRADER

1) Cost of fabrication

S.No	Material	Specification	Quantity	Cost (Rs.)
1	MS round pipe	2" dia	1 No	750
2	MS square pipe	1.5" x 1.5" x 1/8"	1 No	700
3	MS flat	25 x 6 mm	5 kg	250
4	MS sheet	1.5 mm thick	1 No	1000
5	Load cell	20 kg capacity	1 No	3000
6	Proximity sensor	5mm distance detector	1 No	750
7	SS rod	1.5cm dia	1 No	400
8	DC motor	24 V	1 No	3000
9	Pulleys	B type	3 Nos	950
10	Bearings	2" bearing block	2 Nos	1500
11	Pneumatic cylinder	25 mm displacement and 1" dia	3 Nos	1950
12	Direction control valve (DCV)	230 V	3 Nos	1950
13	Regulated power supply (RPS)	15 V output	1 No	6100
14	Air compressor	15 bar working pressure	1 No	12,000
15	Belt		2 Nos	300
16	Welding rods		50 rods	120
17	Software and program			6000
18	Paint and brush			280
19	Miscellaneous expenditure			10,000
20	Fabrication Charge			24,000
	Total			75,000

Total cost of weight grader = Rs. 75,000

2) Cost of operation

Assumptions made

1. Useful life of the machine (n) = 10years
2. Interest on machine cost per year (i) = 12 %
3. Number of working h/yr (180 working days x 8 h/day) = 1440
4. Tax, insurance and shelter charge per year = 5 %
5. Repair and maintenance = 10 %

1. Fixed cost per year

$$\begin{aligned} \text{i) Fixed cost of the unit (C)} &= \frac{i(i+1)^n}{(i+1)^n - 1} \times C \\ &= \frac{0.12(0.12+1)^{10}}{(0.12+1)^{10} - 1} \times 75,000 \\ &= \text{Rs. } 13,254/\text{year} \end{aligned}$$

$$\begin{aligned} \text{ii) Tax, insurance and shelter} &= (75,000 \times 5)/100 \\ &= \text{Rs. } 3,750/\text{year} \end{aligned}$$

$$\begin{aligned} \text{Total fixed cost} &= \text{(i)} + \text{(ii)} \\ &= 13254 + 3750 \\ &= 17004/\text{year} \end{aligned}$$

$$\begin{aligned} \text{Total fixed cost/h for annual use of 1440 h/yr} &= 17004/1440 \\ &= 11.80/\text{h} \end{aligned}$$

2. Variable cost of the machine

$$\begin{aligned} \text{(i) Labour cost @ Rs. 450 / day of 8 hours} &= 450 / 8 \\ &= \text{Rs. } 56.25 / \text{h} \end{aligned}$$

$$\begin{aligned} \text{(ii) Repair and maintenance charges} &= (75,000 \times 10)/(100 \times 1440) \\ &= 5.20/\text{h} \end{aligned}$$

(iii) Cost of electricity

$$\text{Power required to operate the unit} = 9 \text{ V} \times 3 \text{ amp} = 27 \text{ W (0.027 kW)}$$

$$\text{Electricity charge @ Rs. 10/ unit} = 0.027 \times 10 = \text{Rs. 0.27/h}$$

Total variable cost = (i) + (ii)

$$= 61.72/\text{h}$$

Total operation cost of the machine = (1) + (2)

$$= \mathbf{73.52/ h}$$

Capacity for the machine

$$= 248 \text{ kg/h}$$

(Assume average weight of coconut as 500 g)

Therefore the capacity of the machine

$$= 496 \text{ nuts/h}$$

∴ Cost of operation per nut

$$= 73.52/496$$

$$= \mathbf{\text{Re. 0.14/nut}}$$