

A QUANTITATIVE STUDY ON THE RECOVERY COIR FIBRE FROM THE COCONUT HUSK

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SUMMARY

Coir extraction in Ceylon is essentially a domestic or cottage industry in all its phases.

A description of 'Fibre Drum' processing is given as the present study was confined to this technique.

Before the factory trials were commenced a preliminary study was made on seven lots of five retted husks each, in order to get an estimate of the possible quantitative recovery of the various fibrous components of the coconut husk by manual separation.

For the experiment proper six batches of one thousand retted husks each were processed quantitatively in a pair of 'drums' and the weight characteristics of the three main components, viz., Bristle fibre, Mattress fibre and Composite Fibre Dust recovered from the 'breaker' and 'cleaner' machines were recorded. Moisture determinations were made on the various components at progressive stages of processing, and the recoveries of the husk components have been computed on the wet and air-dry basis.

If it is assumed that the recoveries by manual separation approximate the theoretical yields, then the results of the study indicate that in the technique of "Drum" Processing about 50 per cent of the bristle fibre in the husk gets broken down into mattress fibre (33 per cent) and dust (17 per cent).

INTRODUCTION

Coir is the most important product that can be obtained by decortication of the coconut husk. It is an industrial 'hard fibre' of a uniform gold colour. It offers immense possibilities for profitable utilization on account of its natural resilience, durability, resistance to dampness and other properties. By suitable processing, coir can be extracted in the form of bristle fibre and mattress fibre and converted into a variety of products such as matting, rugs, carpets, brushes, brooms and other coir manufactures. The fibre can also be spun into yarn for the manufacture of cordage.

A versatile product of relatively recent origin is "rubberised coir". Owing to its astonishing resiliency and springiness its application in the domestic and industrial fields, as a cushioning material, appears to be almost limitless. In Europe, where the pioneering research work on this product was done, it is now employed widely in the automobile industry, air-conditioning industries, acoustic installation industries, railways, hospitals and in the upholstery trade.

In areas where the husk is not processed for coir, it is generally used for agricultural purposes as both mulch and manure. A small proportion of the considerable amount of pithy residue—"Coir dust", that is separated as a by-product during decortication of the husk, also finds similar use as a soil additive in horticulture.

EXTRACTION OF COIR

Though primitive and relatively modern methods may be seen in operation side by side, coir extraction in Ceylon is essentially a domestic or cottage industry in all its phases, and rests on very old traditions.

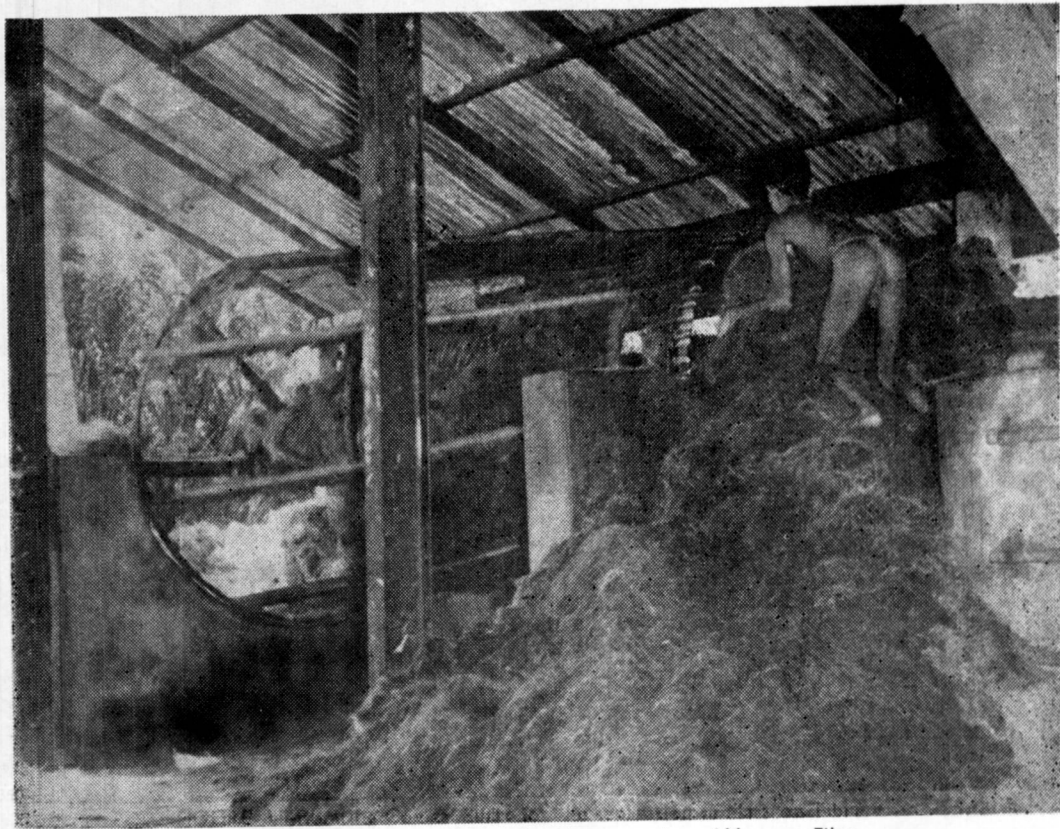


FIGURE 3—Rotating Conical Sifter for the separation of Mattress Fibre.

Primitive Methods

In the typical process the husks are first soaked ("retted") for short or long periods in fresh water, brackish water or mud. (Figure 1). They are next rinsed with water and the fibres separated from them by crushing and beating with wooden stampers or mallets. After washing and drying, the fibre is finally prepared, cleaned and graded by hand hackling.

There is no doubt that with little or no capital outlay, some of these crude methods are effective and yield fibre of the very best quality. Green or raw husks are sometimes processed by these methods without any form of retting. The fibre obtained this way however is generally inferior and is termed "unsoaked coir."

Modern Methods

Modern methods of processing coir are essentially mechanical or mechano-chemical and include both wet and dry techniques. At the present time relatively expensive machinery too have been designed and applied. For the present purpose a description of 'Fibre Drum' processing should suffice as the study was confined to this technique.

The 'Fibre Drum'

In this process, the separation of fibre from the inter-connective tissues of the retted husk is accomplished by special machines called 'fibre drums'. (Figure 2). These machines are arranged in pairs, the first one of which is called the 'breaker' or 'crusher' and the other the 'cleaner' or 'finisher'. They both consist essentially of a wooden wheel approximately 3 feet in diameter with a wide rim bearing 36-38 treads that are approximately 1 foot across and 6 inches long. Each tread is fitted with a set of 30-40 iron teeth that are bolted $1\frac{1}{2}$ to 2 inches apart. In the 'cleaner', these nails are closer spaced, sharper and finer so that 1,400 teeth in all on this drum would correspond to about 1,200 on the 'breaker.'

The wheels are power driven and they revolve at high speed within a wooden guard. The lower part of this cover takes the form of a chute for delivering (well clear of the drum), the material removed by the teeth, to the floor below. The upper part of the guard has an opening (at work bench level) about $1\frac{1}{2}$ feet across and 4 inches high, protected by a pair of rotating iron bars. The ends of these two bars lie in grooves, permitting the upper one to move up and down. Besides facilitating the feeding of the husks to the machine, this arrangement also affords a certain degree of protection to the hands of the operator.

The operator in charge of the 'breaker' drum holds one end of a husk segment and forces the other end against the teeth of the revolving wheel through the two iron bars. The nails tear away the epicarp, pith and much of the short fibres. When he has similarly repeated this operation with the other end of the husk, only the long stapled bristle fibre is left in his hands. Next, the fellow operator on the 'cleaner' drum takes three or four lots of this fibre all together and subjects them to precisely the same treatment. This cleans up the fibre further and removes any short staples not removed by the breaker.

Bristle Fibre. The bristle fibre thus recovered is finally washed and then spread out fanwise on the ground for drying, which would normally be complete in eight hours. The dried fibre is then 'hackled'—that is, combed, by drawing through a row (usually eight in number, 4-6 inches long) of steel spikes spaced about 1 inch apart and mounted vertically on a table. After this operation, which removes a further quantity of pith and short fibres, the bristle fibre is done up into hanks (weighing approximately a pound each), by means of cords of coir twine. The number of cords used for hanking the fibre would serve to indicate its grade and length. Thus 'One Tie', bristle averages 6-8", "Two Tie"—8 to 10" and "Three Tie"—10 to 12" in length. The short stapled fibre left over after final sorting of these grades is described as "O Mat" and is marketed as superior mattress fibre. 100 cwt of mill bristle fibre is generally reckoned to give 87 cwt. of hackled bristle fibre and 10 cwt of "O Mat". The balance 3 per cent would be moisture and mechanical losses consequent on processing.



FIGURE 2—The 'Fibre Drum' in operation.

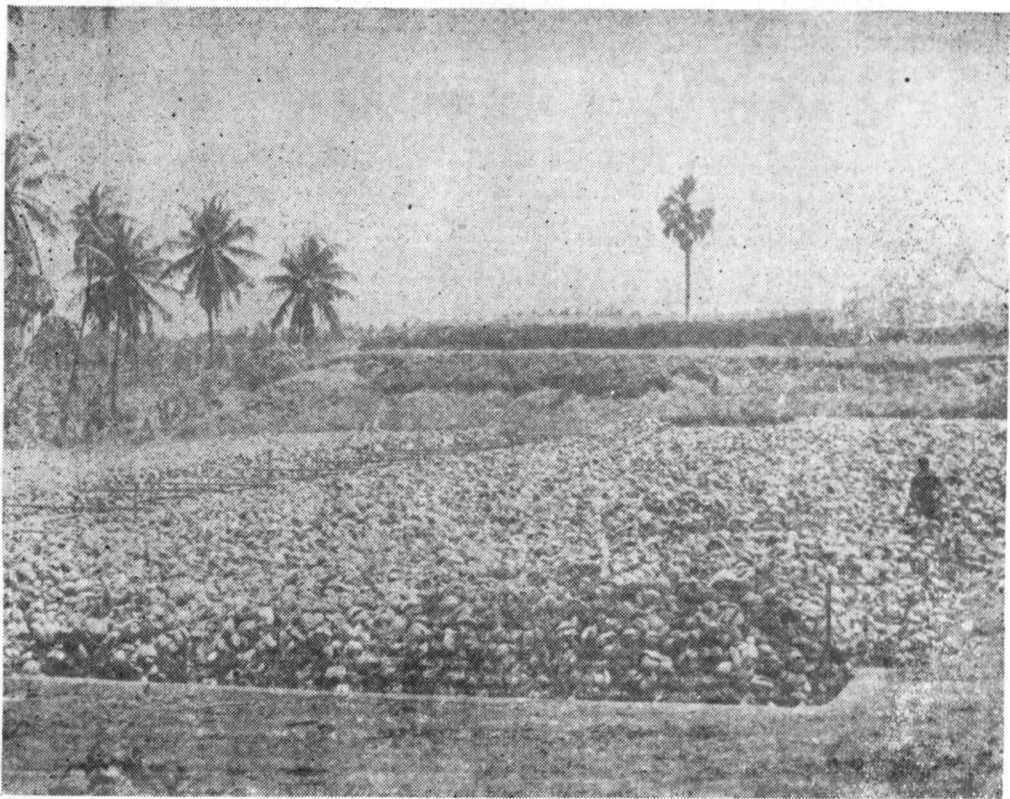


FIGURE 1—Coconut Husks in a Retting Pit.

Mattress Fibre. To recover mattress fibre, the crude mixture of wet fibrous material, pith, epicarp and extraneous matter from the 'breaker' and 'cleaners' is fed into the narrow end of a rotating cone-shaped sifting machine that is meshed with stout $1\frac{1}{2}$ " wire netting. (Figure 3). As this mixture passes along the cone, it is subjected to a sieving action whereby all the short fibres, pith and extraneous matter drop off underneath the machine leaving only the mattress fibre inside, which is finally discharged from the wide end of the cone. The fibre thus sifted out, may sometimes be subjected to vigorous mechanical beating (in order to dislodge any adhering extraneous matter) in a 'teaser'—which is merely a rectangular box fitted with wire mesh at the bottom. After drying in the sun the fibre may either be subjected to further cleaning by rod or machine 'willowing', or directly ballotted and baled.

In an eight hour working day, it is generally reckoned that a pair of drums could process up to 2,000 husks, and some of the larger mills operate as many as 25 pairs of these machines.

EXPERIMENTAL PROCEDURE AND RESULTS

Manual Processing. Before commencing the quantitative factory trials on "Drum Processing" preliminary study was made on seven lots of five retted husks each, to get an estimate of the possible quantitative recovery of the various fibrous components of the coconut husk by manual separation. The five retted husks of each lot were first rinsed with water and the fibrous components were separated from them by hand after crushing and beating with wooden stampers and mallets.

The components separated as described above were Bristle Fibre, Mattress Fibre and Coir fibre Dust. The fibre dust was further separated into Epicarp, Fibrous dust and Corky dust. Accurate moisture determinations were made at each stage of the processing on the wet and air-dry samples of the different components in order to calculate the results obtained on the moisture free basis and compare them with corresponding data for 'drum processing.'

The full results obtained in the preliminary and six quantitative experiments are summarised in Tables I to IV.

"Drum Processing"

For the purpose of this experiment six batches of one thousand retted husks each were processed quantitatively in a pair of "drums" and the weight characteristics of the three main components, viz., Bristle Fibre, Mattress Fibre and Composite Fibre Dust recovered from the 'breaker' and 'cleaner' machines were recorded. Further, the bristle and mattress fibre recovered from each batch of husks were sun-dried as in normal factory procedure to air-dry conditions, and then weighed. On the basis of quadruplicate analyses the moisture contents of the various components (on the wet and air-dry basis) were determined at the progressive stages of processing.

The full experimental results, giving details of recoveries of the different components from the breaker and cleaner machines are charted in Tables V to VII.

TABLE — I

Moisture Contents of the Components of Retted Coconut Husk (Manual Processing)
(Per cent)

BATCH	ORIGINAL RETTED HUSK (Calculated)			BRISTLE FIBRE		MATTRESS FIBRE		COIR FIBRE DUST							
	Wet	Wet (Cor- rected for dryage)	Air Dry	Wet	Air Dry	Wet	Air Dry	EPICARP		FIBROUS DUST		CORKY DUST		COMPOSITE DUST	
								Wet	Air Dry	Wet	Air Dry	Wet	Air Dry	Wet	Air Dry
PRELIMINARY	83.8	79.9	12.2	62.6	9.9	62.5	11.5	—	—	—	—	—	—	87.5	13.8
I	85.3	81.6	7.5	51.8	9.3	49.5	9.3	—	5.2	—	5.8	—	6.7	85.8	9.9
II	84.8	81.3	9.3	58.4	6.2	61.4	8.6	—	8.4	—	10.9	—	12.1	89.7	10.4
III	84.2	82.3	10.2	57.3	8.6	59.7	8.9	—	8.6	—	11.2	—	12.4	86.4	14.7
IV	85.0	83.1	10.7	63.1	8.6	58.4	9.2	—	9.2	—	12.0	—	13.3	85.8	13.6
V	86.3	83.8	10.2	61.2	9.7	66.3	9.4	—	8.8	—	11.0	—	11.9	88.1	11.9
VI	88.0	86.6	10.0	66.4	9.1	71.3	9.3	—	8.7	—	11.0	—	12.5	90.3	9.6
Mean (6)	85.6	83.1	9.6	59.7	8.6	61.1	9.1	—	8.2	—	10.3	—	11.5	87.7	11.7
C.V. (%)	1.5	2.1	10.9	7.8	13.2	11.1	3.1	—	16.4	—	19.9	—	19.0	2.1	16.4

TABLE — II

Data obtained on the Components of the Retted Coconut Husk (Manual Processing)
Wet-Weight Relationships (5 Husks per Batch) (In Grammes)

BATCH	Original Wet Weight of Husks	Dryage during Processing		Original Wet Wt. of Husks (Corrected for Dryage)	BRISTLE FIBRE		MATTRESS FIBRE		COIR FIBRE DUST						
		Weight lost	As % of original		Wet Wt.	As % of original corrected	Wet Wt.	As % of orig. corrected	EPICARP		FIBROUS DUST PLUS CORKY DUST		TOTAL COMPOSITE DUST		
									Wet Wt.	As % of orig. corrected	Wet Wt.	As % of orig. corrected	Wet Wt.	As % of original	As % of original corrected
Preliminary	8,845	1,701	19.2	7,144	794	11.1	1374	19.2	—	—	—	—	4976	56.3..	69.7
I	11,350	2,255	19.9	9,095	1047	11.5	570	6.3	441	4.8	7037	77.4	7478	65.9	82.2
II	9,988	1,864	18.7	8,124	1075	13.2	637	7.8	510	6.3	5902	72.6	6412	64.2	78.9
III	9,988	1,057	10.6	8,931	1190	13.3	625	7.0	533	6.0	6583	73.7	7116	71.2	79.7
IV	10,215	1,145	11.2	9,070	1336	14.7	574	6.3	577	6.4	6583	72.6	7160	70.0	79.0
V	10,896	1,668	15.3	9,228	1304	14.1	941	10.2	627	6.8	6356	68.9	6983	64.1	75.7
VI	11,350	1,209	10.7	10,141	1166	11.3	906	8.8	805	7.9	7264	71.6	8069	71.1	79.5
Mean (6)	10,631	1,533	14.4	9,098	1186	13.0	709	7.7	582	6.4	6621	72.9	7203	67.8	79.3
C. V. (%)	5.6	28.3	26.6	6.5	9.0	9.6	21.7	18.3	19.7	14.5	6.7	3.5	7.0	4.6	2.4

TABLE — III

Dry Weight Relationships (5 husks per Batch) (Air dry Basis)—Manual Processing
(In grammes)

BATCH	Original Dry Weight of Husks (Calculated)	BRISTLE FIBRE		MATTRESS FIBRE		EPICARP		COIR FIBRE DUST				TOTAL COMPOSITE DUST	
		Dry Weight	As % of original	Dry Weight	As % of original	Dry Weight	As % of original	FIBROUS DUST		CORKY DUST		Dry Wt.	As % of original
								Dry Weight	As % of original	Dry Weight	As % of original		
PRELIMINARY	1,634	330	20.2	582	35.6	—	—	—	—	—	—	722	44.2
I	1,806	485	26.9	291	16.1	290	16.1	50	2.8	690	38.2	1,030	57.1
II	1,673	429	25.6	264	15.8	313	18.7	57	3.4	610	36.5	980	58.6
III	1,760	480	27.3	273	15.5	288	16.4	50	2.8	669	38.0	1,007	57.2
IV	1,713	510	29.8	213	12.4	299	17.5	99	5.8	592	34.6	990	57.9
V	1,661	460	27.7	329	19.8	309	18.6	11	0.7	552	33.2	872	52.5
VI	1,515	390	25.7	314	20.7	356	23.5	10	0.7	445	29.4	811	53.6
Mean (6)	1,688	459	27.2	281	16.7	309	18.4	46	2.7	593	35.0	948	56.1
C.V. (%)	5.4	8.6	5.2	13.4	16.7	7.4	13.4	65.7	64.4	13.6	8.8	8.3	4.0

TABLE — IV

**Dry-Weight Relationships (5 Husks)—(Oven-dry Basis)—Manual Processing.
(In Grammes)**

BATCH	Original Dry Wt. of Husks (Calculated)	BRISTLE FIBRE		MATTRESS FIBRE		COIR FIBRE DUST						TOTAL COMPOSITE DUST	
		Dry Wt.	As % of original	Dry Wt.	As % of original	EPICARP		FIBROUS DUST		CORKY DUST		Dry Wt.	As % of original
						Dry Wt.	As % of original	Dry Wt.	As % of original	Dry Wt.	As % of original		
PRELIMINARY	1,434	297	20.7	515	35.9	—	—	—	—	—	—	622	43.4
I	1,670	440	26.3	264	15.8	275	16.5	47	2.8	644	38.6	966	57.9
II	1,517	402	26.5	241	15.9	287	18.9	51	3.4	536	35.3	874	57.6
III	1,581	439	27.8	249	15.7	263	16.6	44	2.8	586	37.1	893	56.5
IV	1,530	466	30.5	193	12.6	271	17.7	87	5.7	513	33.5	871	56.9
V	1,491	415	27.8	298	20.0	282	18.9	10	0.7	486	32.6	778	52.2
VI	1,363	355	26.1	285	20.9	325	23.8	9	0.7	389	28.5	723	53.0
Mean (6)	1,526	420	27.5	255	16.8	284	18.7	41	2.7	526	34.3	851	55.7
C.V. (%)	6.1	8.0	5.5	13.3	16.8	7.0	13.2	64.9	63.3	15.2	9.6	9.3	4.0

TABLE — V (a)

Data obtained on the Components of the Retted Coconut Husk ("Drum") Processing
Wet-weight Relationship (1000 husks per Batch) (In pounds)

1 BATCH	2 Wet Weight of 1000 husks		3 % Adventitious mois- ture.	4 Dryage during Processing					5 Wet Wt. of 1000 husks (correct- ed for Drain- -age & Dryage)	6 No. of Seg- ments	7 OVERALL RECOVERY OF COMPONENTS					
	(a) Drip- ping wet	(b) After draining		Breaker process- ing.	Cleaner process- ing.	TOTAL					BRISTLE FIBRE		MATTRESS FIBRE		COIR FIBRE DUST (Composite)	
						Lbs.	As % of 2 (a)	As % of 2 (b)			Wet Wt. (lbs.)	As % of original (correct- ed)	Wet Wt. (lbs.)	As % of original (correct- ed).	Wet Wt (lbs.)	As % of original (correct- ed).
I	3520	3307	6.1	70	60	130	3.7	3.9	3177	3404	265	8.3	529	16.7	2383	75.0
II	3379	3341	1.1	83	36	119	3.5	3.6	3222	3656	290	9.0	547	17.0	2385	74.0
III	3565	3435	3.6	108	79	187	5.2	5.4	3248	3326	255	7.9	492	15.1	2501	77.0
IV	3465	3440	0.7	54	61	115	3.3	3.4	3325	3298	257	7.7	559	16.8	2509	75.5
V	3589	3570	0.5	47	58	105	2.9	3.0	3465	3390	264	7.6	601	17.3	2600	75.1
VI	3689	3547	3.8	61	63	124	3.4	3.5	3423	3328	265	7.7	550	16.1	2608	76.2
Mean (6)	3534	3440	2.6	70	60	130	3.7	3.8	3310	3400	266	8.0	546	16.5	2498	75.5
C.V. (%)	2.8	2.8	95.5	29.0	21.0	20.5	19.7	20.0	3.2	3.5	4.3	6.1	6.0	4.4	3.6	1.3

TABLE — V (b)

**Details pertaining to Recovery of the Components from the Breaker and Cleaner Machines
Wet Weight Relationships (1000 husks per Batch) (In pounds)**

I	2	3						4						5		
		BREAKER MACHINE						CLEANER MACHINE						TOTAL RECOVERIES		
		Crude Bristle Fibre		Mattress Fibre (1)		Fibre Dust (1)		Cleaned Bristle Fibre		Mattress Fibre (2)		Fibre Dust (2) by Difference		BRISTLE FIBRE	MATTRESS FIBRE	FIBRE DUST (Composite)
		Lbs.	As % of original (Corrected)	Lbs.	As % of original (Corrected)	Lbs.	As % of original (corrected)	Lbs.	As % of original (corrected)	Lbs.	As % of original (corrected)	Lbs.	As % of original (Corrected)	Lbs.	Lbs.	Lbs.
I	3177	905	28.5	276	8.7	1996	62.8	265	8.3	253	8.0	387	12.2	265	529	2383
II	3222	897	27.8	303	9.4	2022	62.8	290	9.0	244	7.6	363	11.2	290	547	2385
III	3248	933	28.7	267	8.2	2048	63.1	255	7.9	225	6.9	453	13.9	255	492	2501
IV	3325	932	28.0	293	8.8	2100	63.2	257	7.7	266	8.0	409	12.3	257	559	2509
V	3465	955	27.6	309	8.9	2201	63.5	264	7.6	292	8.4	399	11.6	264	601	2600
VI	3423	969	28.3	268	7.8	2186	63.9	265	7.7	282	8.3	422	12.3	265	550	2608
Mean (6)	3310	932	28.2	286	8.6	2092	63.2	266	8.0	260	8.0	406	12.2	266	546	2498
C.V. (%)	3.2	2.7	1.4	5.8	5.9	3.7	0.62	4.3	6.1	8.7	6.3	6.9	6.9	4.3	6.0	3.6

TABLE — VI

Dry-Weight Relationships (1000 Husks per batch) (Air-Dry Basis)—“DRUM” Processing
(In pounds)

1 BATCH	2 Original Dry Weight of Husks (calculated)	3 BRISTLE FIBRE (Sud dried) Mean Dryage from wet weight—60.7%		4 MATTRESS FIBRE (Sun dried) Mean Dryage from Wet Wt.—57.4%						5 TOTAL COMPOSITE FIBRE DUST (Calculated to 11.7% Air-dry moisture basis).	
		Dry Weight (lbs)	As % of Original	BREAKER		CLEANER		TOTAL		Dry Weight (lbs)	As % of Original
				Lbs	As % of Total	Lbs	As % of Total	Lbs	As % of Total		
I	664	104	15.7	137	20.6	91	13.7	228	34.3	332	50.0
II	669	113	16.9	134	20.0	90	13.5	224	33.5	332	49.6
III	692	113	16.3	130	18.8	100	14.5	230	33.3	349	50.4
IV	685	95	13.9	148	21.6	92	13.4	240	35.0	350	51.1
V	686	99	14.4	131	19.1	94	13.7	225	32.8	362	52.8
VI	712	103	14.5	151	21.2	94	13.2	245	34.4	364	51.1
Mean (6)	685	104	15.3	138	20.2	94	13.7	233	33.9	348	50.8
C.V. (%)	2.3	6.4	7.1	5.9	5.1	3.5	3.0	3.4	2.2	3.7	2.0

TABLE — VII

Dry-Weight Relationships (1000 husks per batch) (Oven-dry Basis)—“DRUM” Processing.
(In Pounds)

BATCH	Original Dry Weight of Husks (Calculated)	BRISTLE FIBRE (Calculated on a Moisture basis of 73.6)		MATTRESS FIBRE (Calculated on a Moisture basis of 76.1%)						COMPOSITE FIBRE DUST (Calculated on a Moisture basis of 87.9%)	
		Dry Wt. (lbs.)	As % of original	BREAKER		CLEANER		TOTAL		Dry Weight (lbs.)	As % of Original
				Lbs.	As % of Total	Lbs.	As % of Total	Lbs.	As % of Total		
		I	484	70	14.5	66	13.6	60	12.4	126	26.0	288	59.5
II	496	77	15.5	72	14.5	58	11.7	130	26.2	289	58.3
III	488	67	13.7	64	13.1	54	11.1	118	24.2	303	62.1
IV	506	68	13.4	70	13.8	64	12.6	134	26.4	304	60.1
V	529	70	13.2	74	14.0	70	13.2	144	27.2	315	59.5
VI	517	70	13.5	64	12.4	67	13.0	131	25.3	316	61.1
Mean (6)	502	70	13.9	68	13.5	62	12.4	130	25.9	302	60.2
C.V. (%)	3.2	4.6	5.8	5.7	5.0	8.8	5.9	6.0	3.6	3.7	2.0

Basis for the Moisture Contents-used in Computations

BRISTLE FIBRE		MATTRESS FIBRE		COMPOSITE FIBRE DUST	
	% Moisture (Mean of six each)		% Moisture (Mean of six each)		% Moisture (Mean of six each)
From Breaker	75.5	From Breaker	76.5	From Breaker	87.6
From Cleaner	67.1	From Cleaner	75.7	From Cleaner	89.3
Weighted Mean	73.6	Weighted Mean	76.1	Weighted Mean	87.9

DISCUSSION AND CONCLUSION

The overall findings from the experiment on manual processing indicate that the dry matter in the coconut husk would be distributed as follows :—

						<i>Per Cent</i>
Bristle Fibre	...	...	...	...	...	27.5
Mattress Fibre	...	...	...	...	...	16.8
Coir Fibre Dust						
(a) Epicarp	...	...	...	...	...	18.7
(b) Fibrous Dust	...	...	...	...	...	2.7
(c) Corky Dust	...	...	...	...	...	34.3
						} 55.7%
					Total	100.0
						100.0

The average results on "Drum Processing" show that the dry matter in one thousand husks weigh 502 lbs. On this basis, the above findings for 'Manual Processing' could be expressed (in terms of weights) as follows :—

Recoveries of Components (in lbs)—Moisture free basis

						<i>Pounds</i>
Bristle Fibre	...	...	...	...	...	138.0
Mattress Fibre	...	...	...	...	...	84.3
Coir Fibre Dust						
(a) Epicarp	...	...	...	...	...	93.9
(b) Fibrous Dust	...	...	...	...	...	13.6
(c) Corky Dust	...	...	...	...	...	172.2
						} 279.7
					Total	502.0
						502.0

To obtain wet weight relationships the above data could of course be re-calculated for any required moisture content of the components involved.

With regard to 'Drum' Processing, the overall findings indicate that the dry matter in the husk gets distributed as follows :—

						<i>Per Cent</i>
Bristle Fibre	...	...	...	...	...	13.9
Mattress Fibre	...	...	...	...	...	25.9
Composite Fibre Dust	...	...	...	...	...	60.2
						100.0
						100.0

In terms of weights, the above findings could be expressed as follows :—

<i>Recoveries of Components (in lbs)—Moisture free basis</i>						<i>Pounds</i>
Bristle Fibre	...	...	...	...	...	70.0
Mattress Fibre	...	...	...	...	...	130.0
Composite Fibre Dust	...	...	...	...	...	302.0
						502.0
						502.0

If it is assumed that the recoveries by manual separation approximate the theoretical yields, then in general, the conclusion can be drawn that in the technique of Drum Processing, about 50 per cent of the bristle fibre in the husk gets broken down into mattress fibre (33 per cent) and dust (17%).

This study on the recovery of coir fibre from the coconut husk was made consequent on certain claims that have been made for an imported coir extraction machine of Austrian manufacture. It is hoped that it will become possible to repeat the study on similar quantitative lines with this machine.

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