







Characterization & Quantification of Waste Agricultural Biomass District Sanghar Pakistan

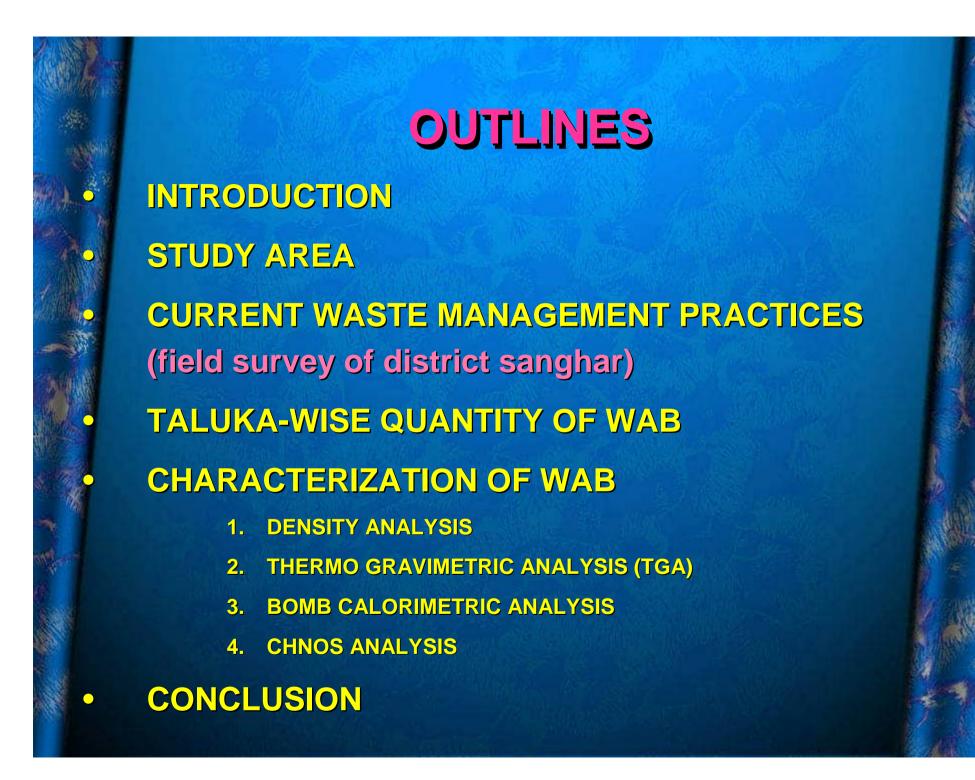


By: Prof. Dr. Rasool Bux Mahar

Institute of

Environmental Engineering & Managment,

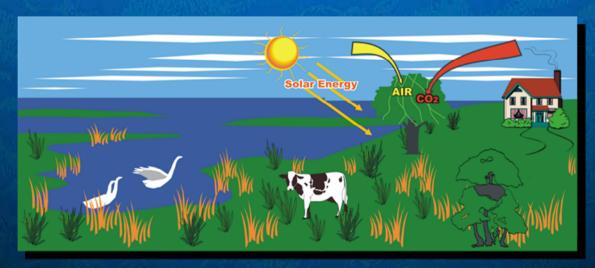
Mehran University of Engineering & Technology Jamshoro, Pakistan



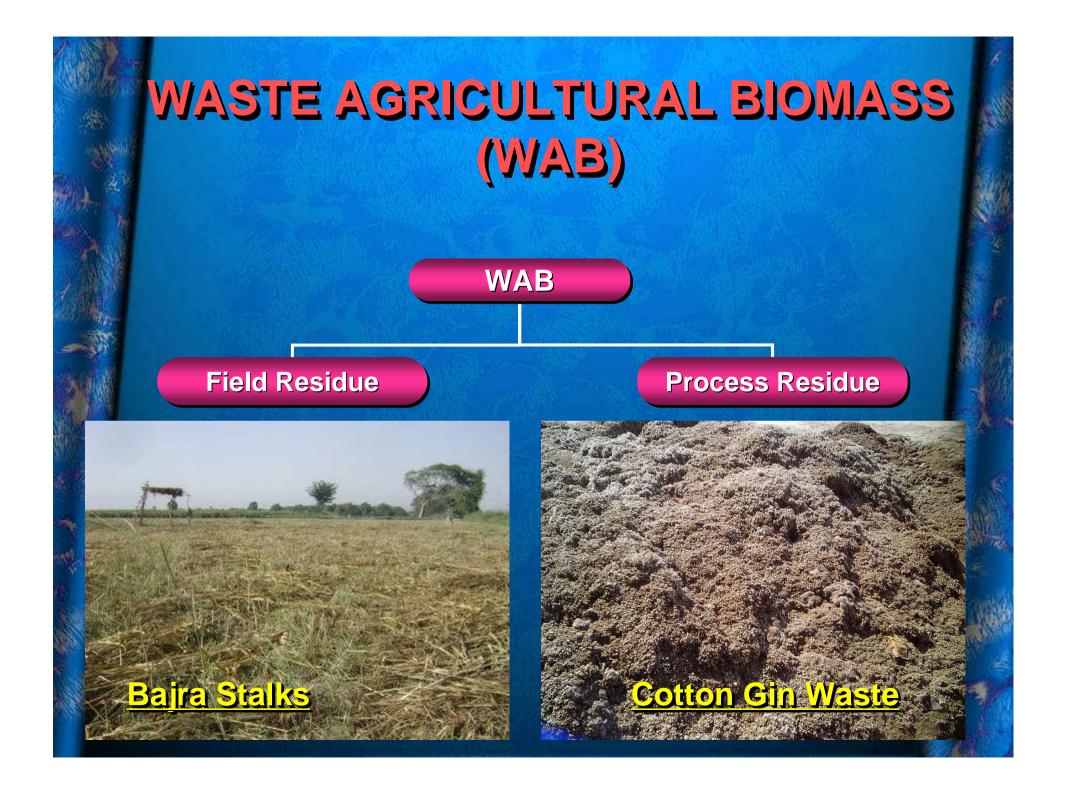
INTRODUCTION

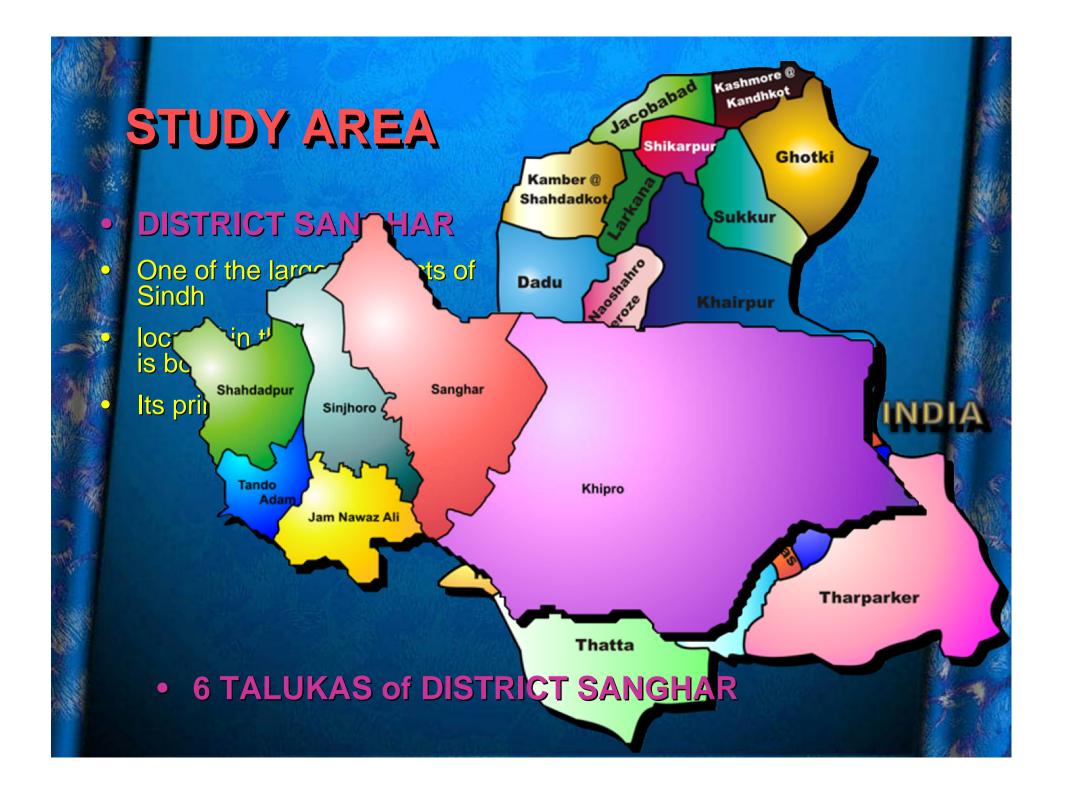
The biomass is one of them, defined as "any organic matter which is available on a renewable basis, including agricultural crops and agricultural wastes and residues, wood and wood wastes and residues, animal wastes, municipal wastes, and aquatic plants."

This piece of work has focused on the characterization, quantification agricultural wastes and residues.



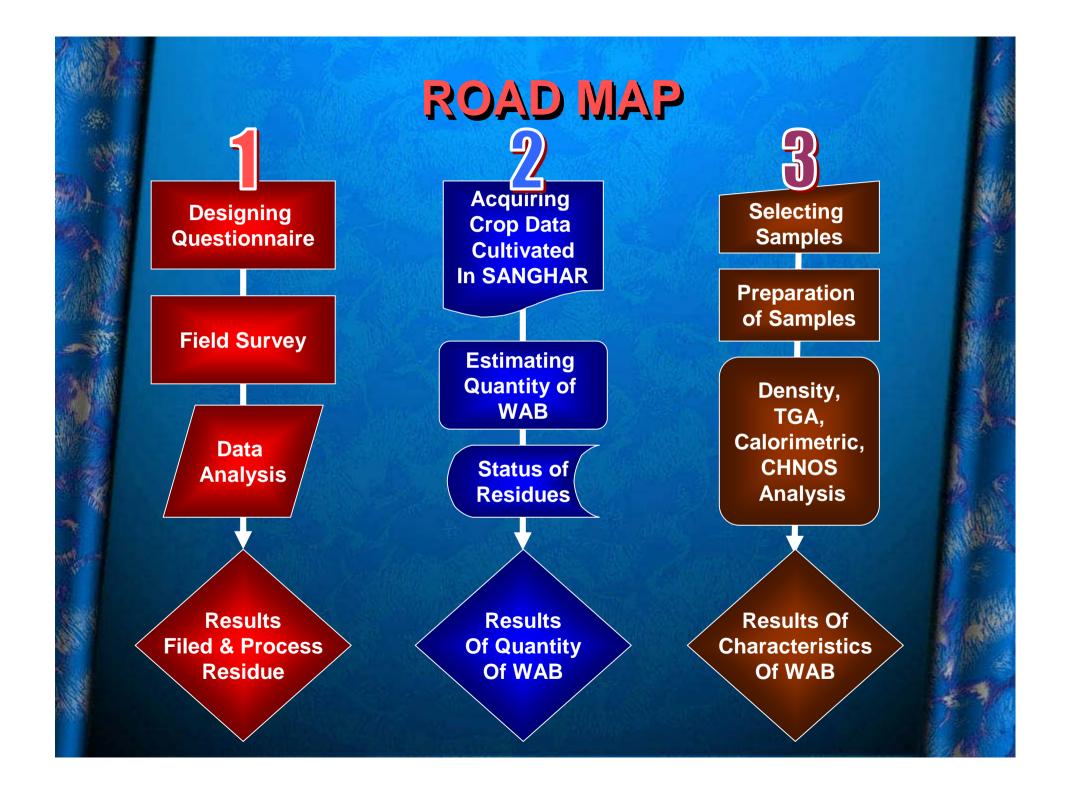
$$6CO_2 + 6H_2O \xrightarrow{Sunlight_1} C_6H_{12}O_6 + 6O_2$$

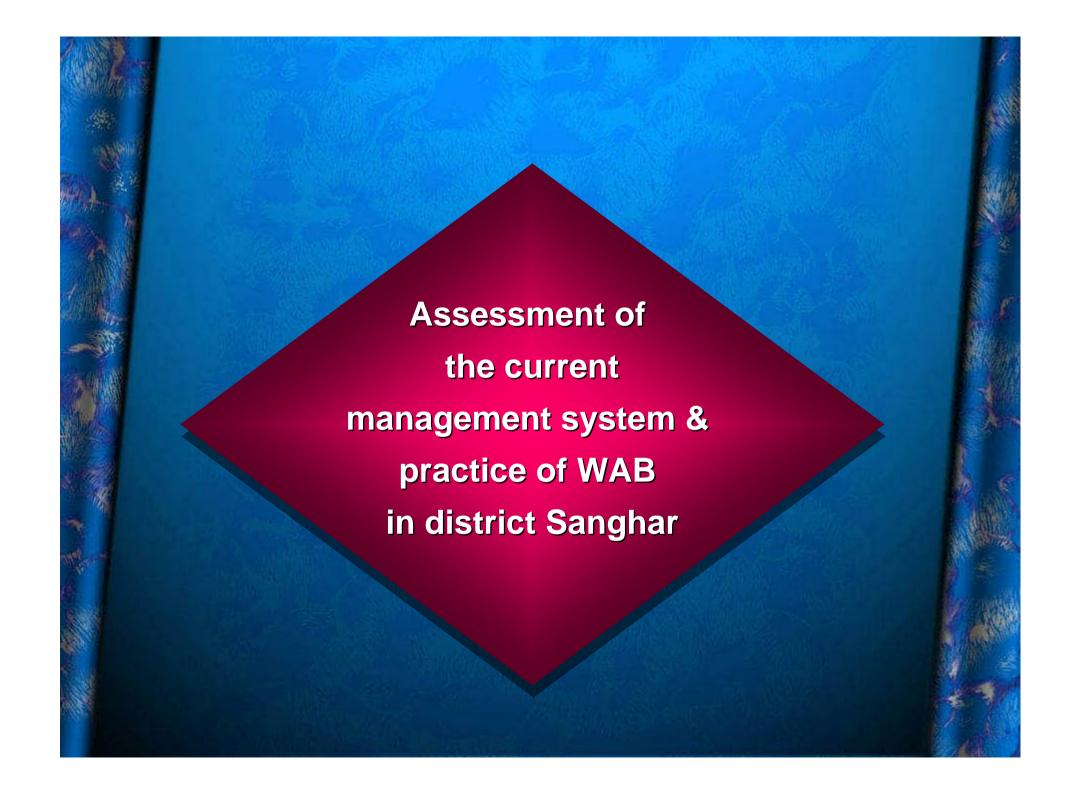




Area and Population of District Sanghar by Taulka

S#	Name of taluka	Area (Acre)	No of Dehs	Union Councils	Population by census 1998	Growth rate	Population in 2010
1	Sanghar	590782	69	11	262050		362459
2	Sinjhoro	217070	88	8	196849		272275
3	Shahdadpur	108377	47	13	327408		452860
4	Tando Adam	107688	28	10	255941	2.74%	354009
5	Jam Nawaz Ali	115021	51	4	88908		122975
6	Khipro	1300766	78	13	321874		445206
	Total	2439704	361	59	1453030		2009784





FIELD SURVEY OF DISTRICT SANGHAR

- **5** Questionnaires were Designed
 - 1. Field Residue
 - 2. Rice Mills
 - 3. Wood Mills
 - 4. Poultry Forms
 - 5. Brick Kilns

Summary of the Field Survey

Summary of the Field Survey	No
No of taulka of District Sanghar	6
No of Union Councils	59
No of interviews conducted from farmers	1180
No of Rice Mills surveyed	39
No of wood Mills surveyed	80
No of poultry forms surveyed	60
No of bricks kilns surveyed	22

CRITICAL ANALYSIS OF DATA

Weighted Average = $\frac{\sum a_i r_i}{\sum a}$

where

a = cultivated area / crop production

r = yield / residue ratio / price

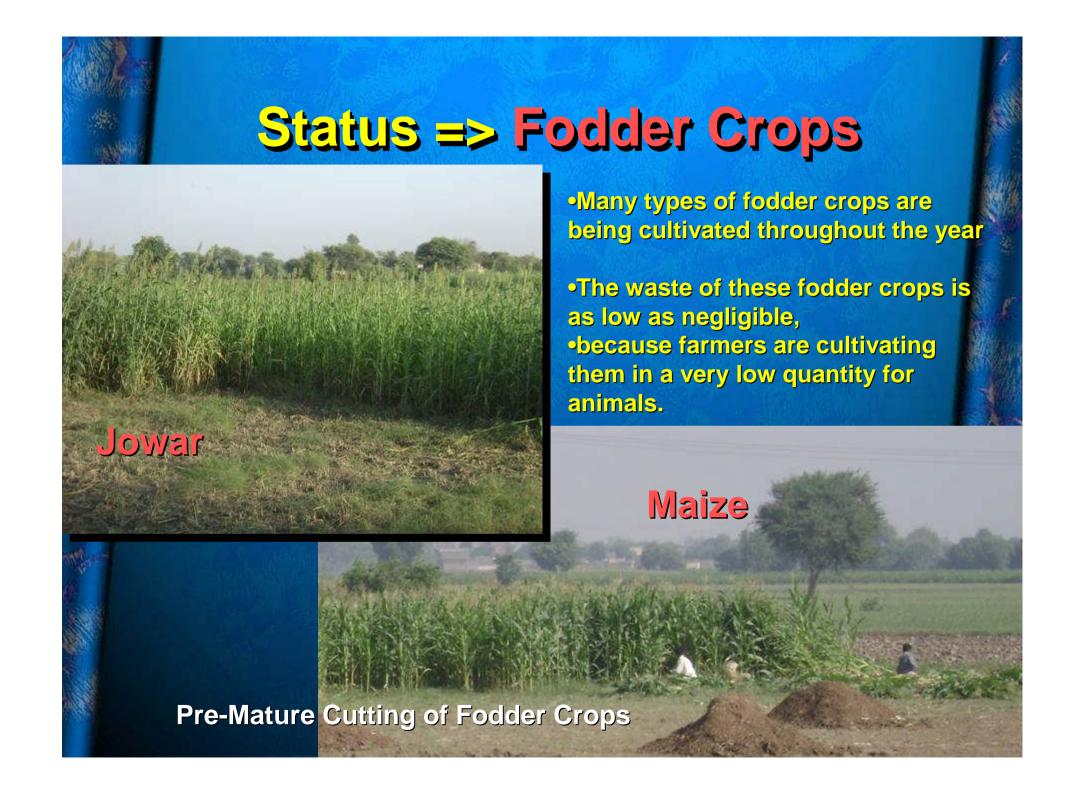
Weighted average in conjunction to the percentage function was also used to determine the usage of the waste / residue, energy used for cooking & lighting, use of animal dung etc.

Status => Cotton and Cotton Stalks

				ROWN - USA				Usage	e (%)		
S N o	Name of Taluka	Crop Yield (mons/ acre)	Yield to Residue Ratio	Residue Price (Rs./mon)	Availability in a year	Animal Feed	Cooking	Open Dumping	Filed Burning	Sell	Other
1	Sanghar	33	1:3	55	October to November	0	75	0	25	0	0
2	Sinjhoro	40	1:3	46	November to December	10	45	0	45	0	0
3	Shahdadpur	37	1:3	46	November to December	10	40	0	50	0	0
4	Tando Adam	35	1:3	40	October to November	0	30	0	70	0	0
5	Jam Nawaz Ali	44	1:3	40	November to December	10	10	0	80	0	0
6	Khipro	48	1:3	42	November to December	0	35	0	65	0	0

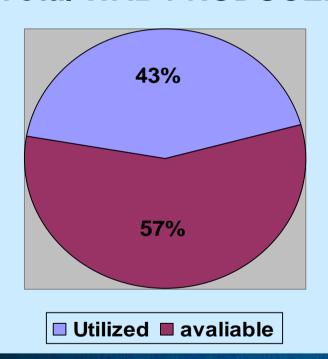


- Sugarcane
- Rice
- Canola
- Wheat
- Banana
- Onion
- Chillies
- Fodder Crops



Current WAB Management Status

Total WAB PRODUCED



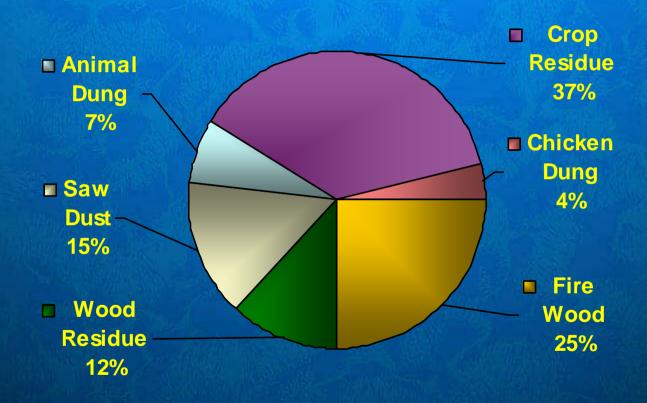
Total Available WAB



About 43% of Total WAB is utilized for animal feed, in brick kiln and for cooking as a heat source

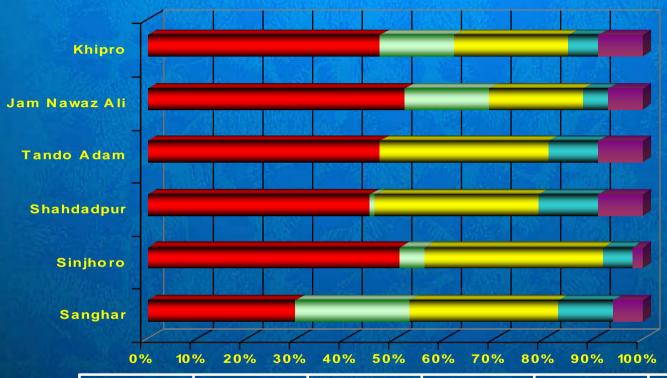
About 57% of Total WAB is available; in which 72% is disposed off WAB and 28% can be purchased

ENERGY USED IN BRICK KILNS



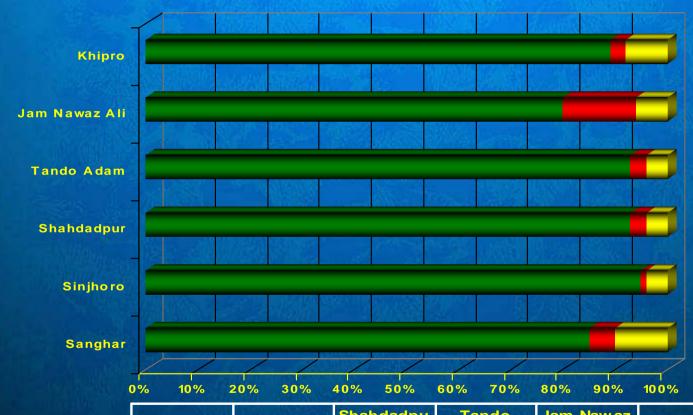
Moreover all the visited poultry forms were using electricity as an energy source.

HEAT ENERGY FROM CROP RESIDUE AND OTHER SOURCES USED FOR COOKING



	Sanghar	Sinjhoro	Shahdadpu r	Tando Adam	Jam Nawaz Ali	Khipro
Natural Gas	6	2	9	9 222	7	9
Animal Dung	11	6	12	10	5	6
Crop Residue	30	36	33	34	19	23
■ Wood Residue	23	5	1 1	0	17	15
Fire Wood	30	51	45	47	52	47

USE OF ANIMAL DUNG FOR COOKING AND OTHERS

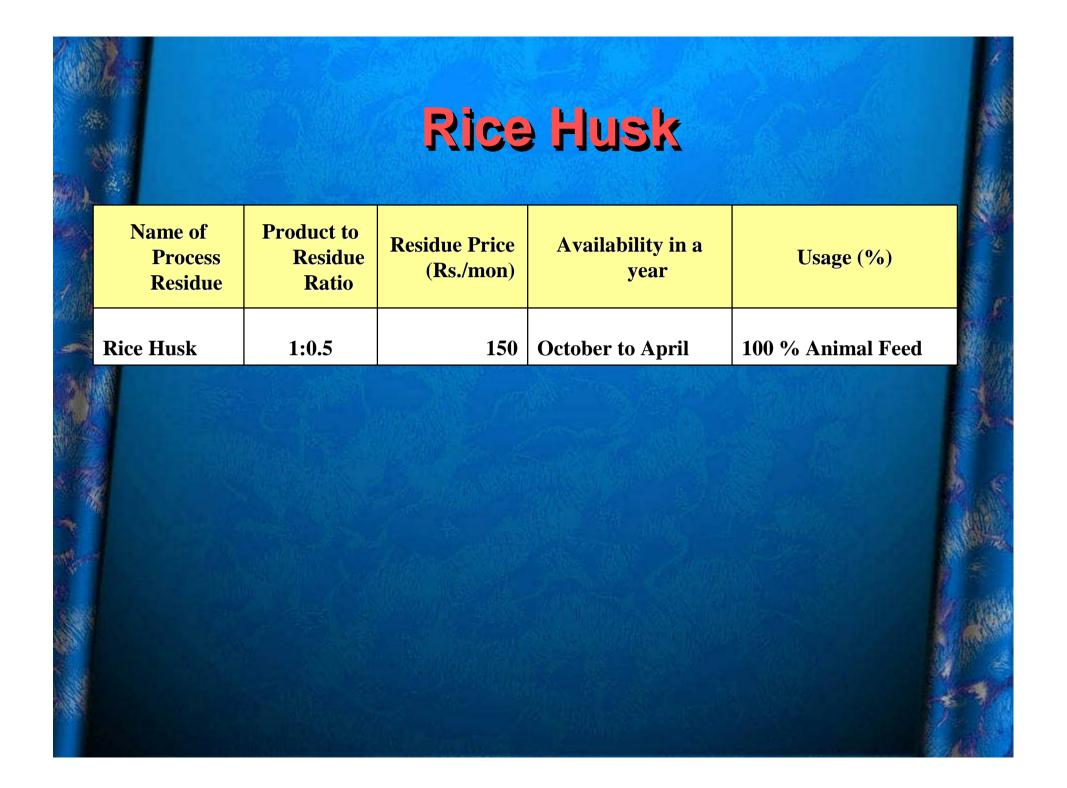


	Sanghar	Sinjhoro	Shahdadpu r	Tando Adam	Jam Nawaz Ali	Khipro
Cooking	10	4	4	4	6	8
■ Sell	5	1	3	3	14	3
Organic Manure	85	95	93	93	80	89

ENERGY USED FOR LIGHTING

■ Electricity 100%

• Electricity throughout the results of field survey, except in taluka Sanghar and Jam Nawaz Ali, where lighting is also done by burning kerosene oil.



Baggase (Sanghar Sugar Mill) (tons)

OH	? #	Description	2006-07	2007-8	2008-9	Average of 3 Years
	1	Sugarcane Processed	526439.249	853591.585	597111.271	659047.368
	2	Baggase Generated (Dry)	77634.804	124572.566	87887.418	96698.263
	3	Molasses	26100.000	49360.000	30279.180	35246.393
	4	Filter cake/ Mud	15793.177	25607.748	17913.338	19771.421
	5	Surplus Baggase (Dry) 5% of Total	3881.740	6228.628	4394.371	4834.913
	6	Baggase Generation Ratio	0.147	0.146	0.147	0.147
	7	Molasses Generation Ratio	0.050	0.058	0.051	0.053
	8	Filter Cake/ Mud Generation Ratio	0.030	0.030	0.030	0.030

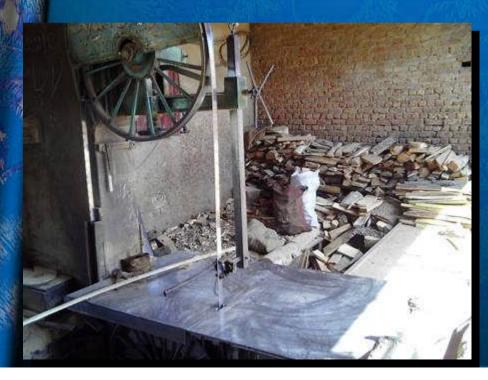


Name of Process Residue	Residue Ratio (mon/mon of cotton)	Residue Price (Rs./mon)	Availability in a year	Usage (%)
Cotton Gin Waste	1:0.135	80	July to March	100% sell



Wood Saw Dust

Name of Process Residue	Product to Residue Ratio	Residue Price (Rs./mon)	Availability in a year	Usage (%)
Saw Dust	1:0.06	80	Full year	100% Sell





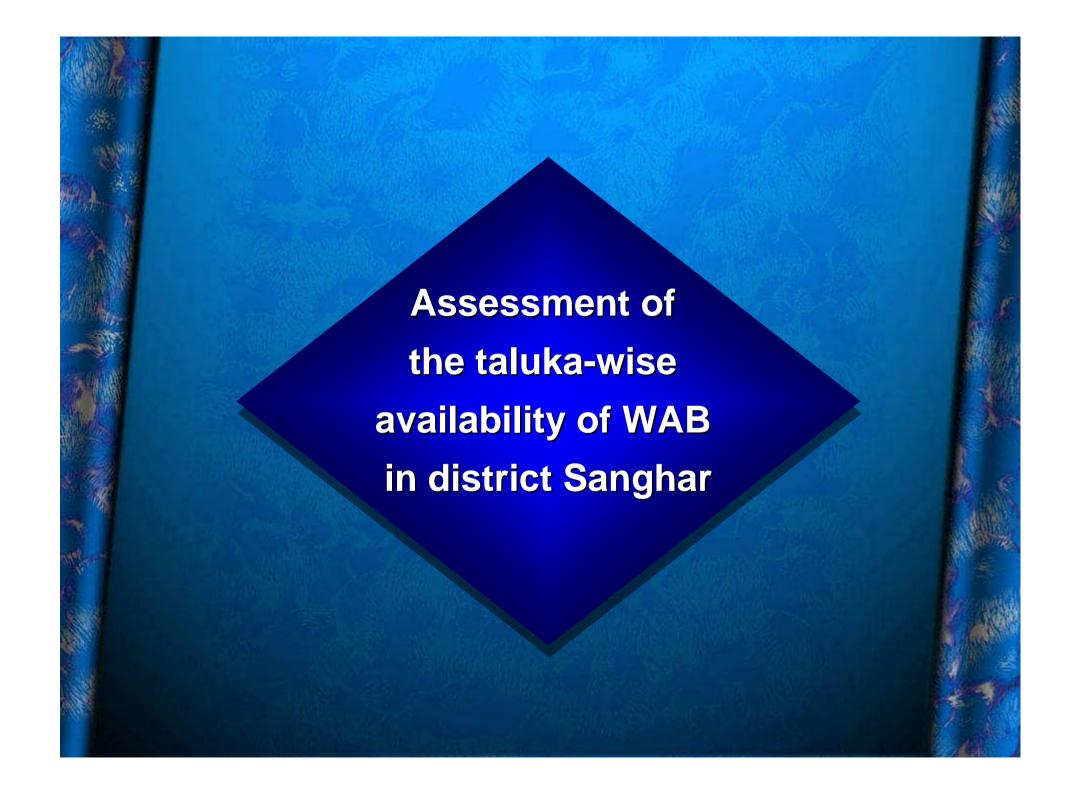


るをはいい	Name of Waste/ residue	Chicken Dung Ratio	Residue Price (Rs./mon)	Availability in a year	Usage (%)	
	Poultry Waste	1:0.21	40	Full year	100% sell	



ENERGY USED IN RICE MILLS Khipro Jam Nawaz Ali Tando Adam Shahdadpur Sinjhoro Sanghar 10% 80% 90% 100% Jam Nawaz **Sinjhoro** Shahdadpur **Khipro** Sanghar **Tando Adam** Ali 15 15 15 0 0 Diessel 85 100 Electricity 85 100 85 100

ENERGY USED BY WOOD SAW MILLS Khipro Jam Nawaz Ali Tando Adam Shahdadpur Sinjhoro Sanghar 100% Jam Nawaz **Tando Adam Sinjhoro** Shahdadpur **Khipro** Sanghar Diessel 5 0 0 0 0 0 100 95 100 100 100 100 **Electricity**



LAST 3 YEARS CROP PROCUDTION IN DISTRICT SANGHAR continued

Minn.							
S	Name		2006-07	2007-8	2008-9	3 Years	Average
No	of Crop	Name of Taluka	Area (hectars)	Area (hectars)	Area (hectars)	Area (hectars)	Area (acres)
	Rabi Vegetables	Sanghar	10	47	Sage (29	70
Mary Control		Sinjhoro	7	53	Jan Shi	30	74
		Shahdadpur	20	72	Data was	46	114
13		Tando Adam	11	79	not avaliable	45	111
		Jam Nawaz Ali	0	37		19	46
		Khipro	4	39		22	53
		TOTAL	52	327	MONTH WILL	190	468
4	×	Sanghar	60	26		43	106
	Thai	Sinjhoro	17	18		18	43
	rif \	Shahdadpur	31	16	Data was not	24	58
14	Veg	Tando Adam	25	22	avaliable	24	58
	eta	Jam Nawaz Ali	8	8		8	20
	Kharif Vegetables	Khipro	7	20	Salare A	14	33
	S	TOTAL	<u>148</u>	110		<u>12</u> 9	319

Taluka-wise Quantity of WAB

Quantity of WAB per Year = AAC × CY × YRR (mons)

where

- AAC = Annual Area Cultivated (acres)
- CY = Crop Yeild (mons/acre)
- YRR = Yield to Residue Ratio

Quantity of WAB in taulka Sanghar

SNO	Name of Crop	Annual Area Cultivated (acres)	Crop Yield (mons/ acre)	Residue	Yield to Residue Ratio	Quantity per year (mons)	Quantity per year (tons)
1	Wheat	55431	33	Straw	1.000	1829212	73168
	Cotton	E4040	22	Stalks	3.000	5729417	229177
2		57873	33	Gin Waste	0.135	257824	10313
	Sugarcane	9760	582	Tops	0.300	1704068	68163
3				Bagasse	0.147	834993	33400
	n.	2050		Straw	1.100	185079	7403
4	Rice	3059	55	Husk	0.500	84127	3365
5	Canola	7550	16	Straw	1.100	132878	5315
6	Banana	96		Plant	367	35368	1415
		TOTAL	431719				
		4		o-tons			1

Quantity of WAB in taulka Sinjhoro

ķ,								
	o	Name of Crop	Annual Area Cultivated (acres)	Crop Yield (mons/ acre)	Residue	Yield to Residue Ratio	Quantity per year (mons)	Quantity per year (tons)
2000	1	Wheat	74692	46	Straw	1.000	3435819	137433
			66290	40	Stalks	3.000	7954816	318193
	2	Cotton	00290	40	Gin Waste	0.135	357967	14319
200			5859	838	Tops	0.300	1472920	58917
	3	Sugarcane			Bagasse	0.147	721731	28869
1			000		Straw	1.100	504699	20188
ı	4	Rice	8657	53	Husk	0.500	229409	9176
	5	Canola	2633	23	Straw	1.100	66623	2665
	6	Banana	315		Plant	367	115476	4619
								3860

594 kilo-tons

TOTAL

Quantity of WAB in taulka Shahdadpur

Sec.							
S N o	Name of Crop	Annual Area Cultivated (acres)	Crop Yield (mons/ acre)	Residue	Yield to Residue Ratio	Quantity per year (mons)	Quantity per year (tons)
1	Wheat	69410	41	Straw	1.000	2845820	113833
		70979	37	Stalks	3.000	7878619	315145
2	Cotton			Gin Waste	0.135	354538	14182
		3660	888	Tops	0.300	974926	38997
3	Sugarcane		000	Bagasse	0.147	0.147 477714	19109
I		1362	47	Straw	1.100	70435	2817
4	Rice			Husk	0.500	32016	1281
5	Canola	2707	22	Straw	1.100	65500	2620
6	Banana	1922		Plant	367	705248	28210
		of Pages 17 Commen	STATE OF STREET	MIDTELLION STATE	C LANGUAGE TO THE PARTY OF THE	The state of the s	5500

536 kilo-tons

TOTAL

Quantity of WAB in taulka Tando Adam

S N o	Name of Crop	Annual Area Cultivated (acres)	Crop Yield (mons/ acre)	Residue	Yield to Residue Ratio	Quantity per year (mons)	Quantity per year (tons)
* 1	Wheat	33041	40	Straw	1.000	1321651	52866
*		30424	r S	Stalks	3.000	3194480	127779
2	Cotton	30424	35	Gin Waste	0.135	143752	5750
		4890	797	Tops	0.300	1169251	46770
3	Sugarcane			Bagasse	0.147 572933	22917	
		1931 Rice	51	Straw	1.100	108313	4333
4	Rice			Husk	0.500	49233	1969
5	Canola	2473	20	Straw	1.100	54399	2176
6	Banana	3325		Plant	367	1220354	48814
				THE PLANT SHOW			100

313 kilo-tons

TOTAL

Quantity of WAB in taulka Jam Nawaz Ali

S N o	Name of Crop	Annual Area Cultivated (acres)	Crop Yield (mons/ acre)	Residue	Yield to Residue Ratio	Quantity per year (mons)	Quantity per year (tons)
- T	Wheat	21776	34	Straw	1.000	740375	29615
		21682	44	Stalks	3.000	2862004	114480
2	Cotton			Gin Waste	0.135	128790	5152
		1700	869	Tops	0.300	443212	17728
3	Sugarcane	1700		Bagasse	0.147	217174	8687
		3291	46	Straw	1.100	166505	6660
4	Rice			Husk	0.500	75684	3027
5	Canola	1043	16	Straw	1.100	18353	734
6	Banana	142	<u> </u>	Plant	367	52297	2092
				WARTER ST.			5247

188 kilo-tons

TOTAL

Quantity of WAB in taulka Jam Khipro

Aug.		STORY TO SAME				THE PARTY OF THE P	
S N o	Name of	Annual Area Cultivated (acres)	Crop Yield (mons/ acre)	Residue	Yield to Residue Ratio	Quantity per year (mons)	Quantity per year (tons)
1	Wheat	45106	48	Straw	1.000	2165078	86603
	W. L	55270	48	Stalks	3.000	7958889	318356
2	Cotton	55470	70	Gin Waste 0.135 358	358150	14326	
		1020	955	Tops	0.300	555510	22220
3	Sugarcane	1939	955	Bagasse	0.147	272200	10888
J		7072	30	Straw	1.100	233381	9335
4	Rice			Husk	0.500	106082	4243
5	Canola	1891	18	Straw	1.100	37445	1498
6	Banana	121		Plant	367	44437	1777
				HINTER OF STREET			

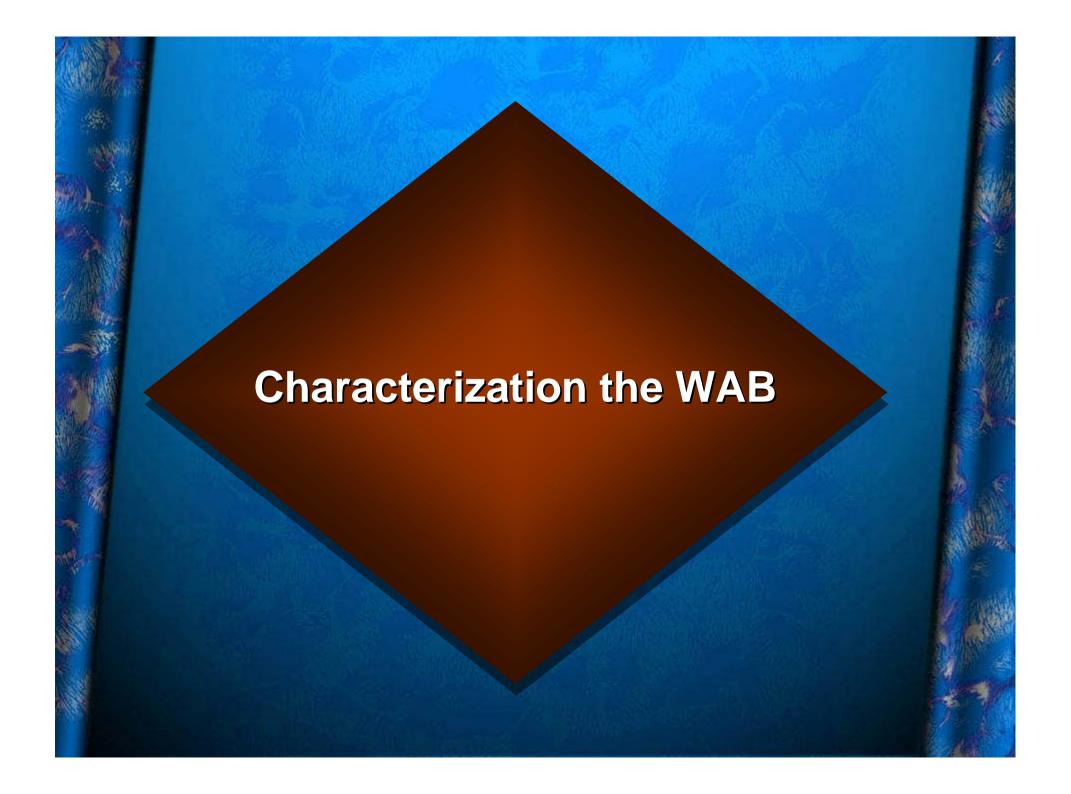
469 kilo-tons

TOTAL

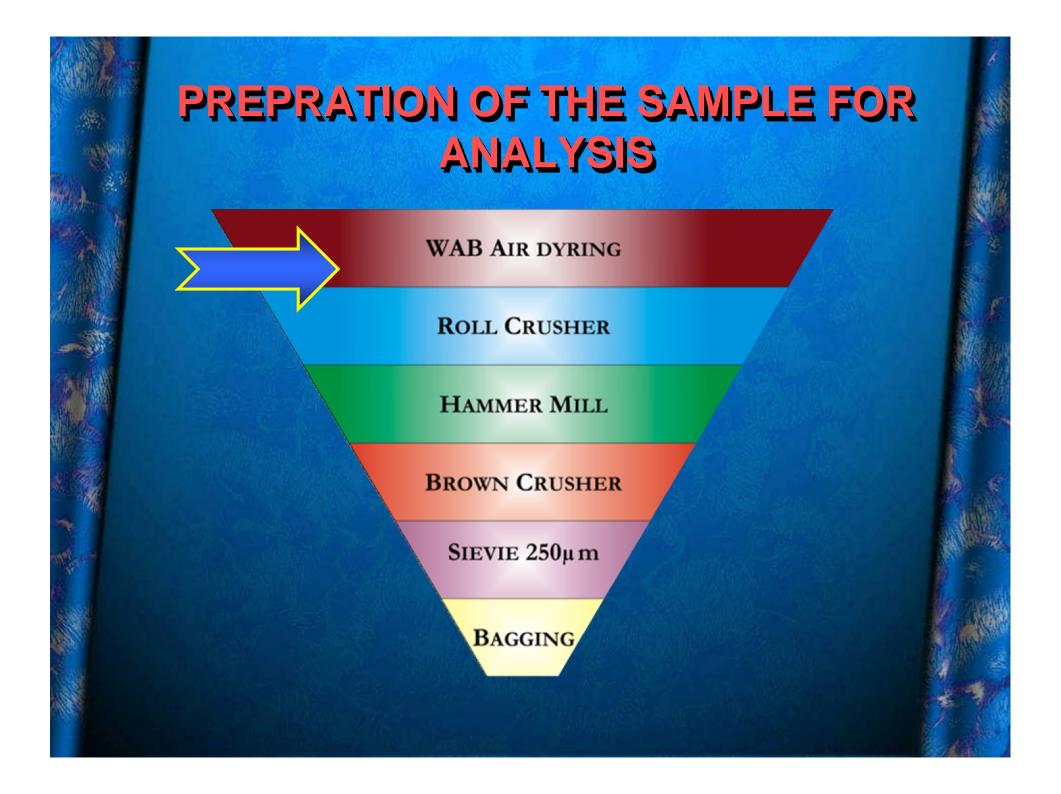
Total quantity of WAB in district Sanghar (tones)

				MICE PARTY	G THE WAYNE	0000 190 200	9: 42331 HS000	
S N o	Taulka WAB type	Sanghar	Sinjhoro	Shahdad- pur	Tando Adam	Jam Nawaz Ali	Khipro	TOTAL
1,1	Wheat Straw	73168	137433	113833	52866	29615	86603	493518
2	Cotton Stalks	229177	318193	315145	127779	114480	318356	1423129
3	Cotton Gin Waste	10313	14319	14182	5750	5152	14326	64041
4	Sugarcane Tops	68163	58917	38997	46770	17728	22220	252795
5	Sugarcane Baggase	33400	28869	19109	22917	8687	10888	123870
6	Rice Straw	7403	20188	2817	4333	6660	9335	50737
7	Rice Husk	3365	9176	1281	1969	3027	4243	23062
8	Canola Straw	5315	2665	2620	2176	734	1498	15008
9	Banana Plant	1415	4619	28210	48814	2092	1777	86927
	TOTAL	431719	<u>594378</u>	<u>536193</u>	<u>313375</u>	<u>188176</u>	<u>469247</u>	2533087

Total Quantity = 2533 kilo-tons



S No	Name of Sample	Density Analysis	Thermo gravimetric Analysis	Bomb Calorimetric Analysis	CHNOS Analysis
001	Banana Plant	Yes	Yes	Yes	Yes
002	Baggase	Yes	Yes	Yes	Yes
003	Canola	Yes	Yes	Yes	Yes
004	Cotton Stalks	Yes	Yes	Yes	Yes
005	Maize Cob	Yes	Yes	Yes	Yes
006	Rice Husk	Yes	Yes	Yes	Yes
007	Rice Straw	Yes	Yes	Yes	Yes
008	Saw Dust	Yes	Yes	Yes	Yes
009	Sugarcane Tops	Yes	Yes	Yes	Yes
010	Wheat Straw	Yes	Yes	Yes	Yes
011	Cotton Gin Waste	Yes	Yes	Yes	Yes



Different Crushers

(Chemical Engineering Department)



Roll Crusher



Hammer Mill



Brown Crusher





Partially Crushed Samples for (DA)



Baggase





Banana



Wheat Straw Saw Dust



Cotton Stalks



Rice Straw



Cotton Gin Waste



Rice Husk



Sugarcane Tops



Maize Cob



Canola

Results of density Analysis

S No	Name of Sample	Mass (g)	Volume (ml)	Density (g/cm³)
1	Baggase	7.205	25.0	0.288
2	Banana	7.161	28.0	0.256
3	Canola	7.499	28.0	0.268
4	Cotton Jining Waste	7.645	24.0	0.319
5	Cotton Stalks	7.575	8.0	0.947
6	Maize Cob	7.233	8.0	0.904
7	Rice husk	7.069	7.5	0.943
8	Rice Straw	7.417	11.0	0.674
9	Saw Dust	7.203	9.0	0.800
10	Sugarcane Tops	7.484	7.5	0.998
11	Wheat straw	7.160	23.0	0.311

THERMO GRAVIMETRIC ANALYSIS (TGA)





Samples in the range of 15 to 30 milli-grams

TGA result of baggase sample



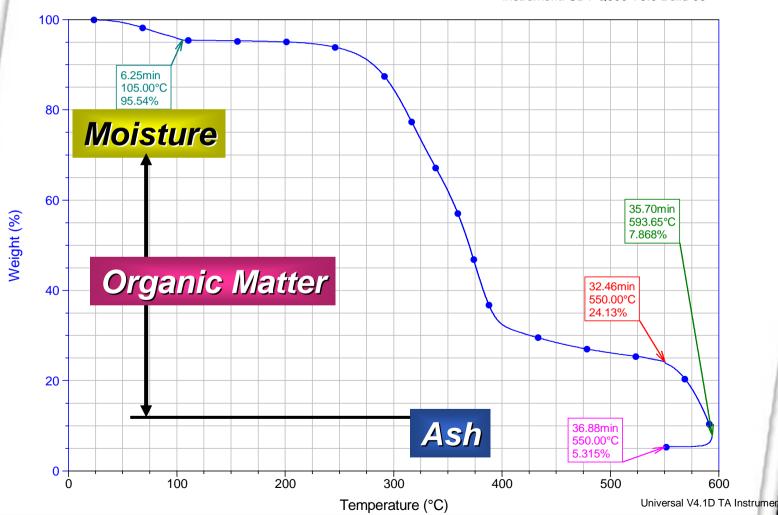
Method: ARS-CRA-baggase-02

DSC-TGA

File: C:\TA\Data\SDT\ARS-baggase -02.001

Operator: Memon Saeed Run Date: 2009-10-26 11:00

Instrument: SDT Q600 V8.0 Build 95



Results of TGA Analysis for WAB

- Contraction							
	S	ır	Name of Sample	Moisture	Volatile at 550 C	Organie (%)	Ash (%)
		0		(%)	(%)		
		1	Banana Plant	5.965	58.955	77.330	16.705
The state of the s		2	Baggase	3.115	73.085	92.165	4.721
		3	Canola	9.085	62.400	81.377	9.538
The state of the s	4	4	Cotton Stalks	4.850	60.455	85.171	9.979
No. of the least o		5	Maize Cob	4.580	68.680	88.695	6.725
100		6	Rice Husk	4.800	58.440	74.620	20.580
	•	7	Rice Straw	3.325	60.195	77.930	18.745
		8	Saw Dust	7.675	63.720	86.022	6.304
		9	Sugarcane Tops	2.430	64.810	83.955	13.615
	10	0	Wheat Straw	4.325	61.345	81.040	14.635
	1	1	Cotton Gin Waste (70% seed + 30%	4.548	58.073	74.679	20.773

Bomb Calorimeter



1.0 g of WAB was
Taken for
calorimetric analysis



CALCULATING CALORIFIC VALUE

 $HCV = (TD \times 2000 + 585)/M_s$

where

HCV = Higher Calorific Value in kcal/kg

M_s = Mass of Sample in grams

T₁ = Inner Cylinder Temperature before Ignition in ° C

T₂ = Inner Cylinder Temperature before Ignition in ° C

T₃ = Inner Cylinder Temperature after Ignition in ° C

T₄ = Inner Cylinder Temperature after Ignition in ° C

TD = Temperature Difference of Inner Cylinder (= T_3 - T_1) in ° C

Results of Bomb Calorimetric Analysis

								The state of the s
S	Name of Sample	Ms	T'1	T'2	T'3	T4	TD	HCV (kcal/kg)
1	Banana Plant	0.870	0.090	0.030	1.190	1.100	1.100	3201
2	Baggase	0.970	0.629	0.469	2.233	2.143	1.604	3910
3	Canola	0.950	0.170	0.150	1.552	1.500	1.382	3525
4	Cotton Stalks	0.990	0.759	0.644	2.273	2.262	1.514	3649
5	Maize Cob	0.890	0.639	0.599	2.034	1.974	1.395	3792
6	Rice Husk	0.830	0.225	0.080	1.351	1.290	1.126	3418
7	Rice Straw	0.970	0.230	0.100	1.562	1.480	1.332	3349
8	Saw Dust	0.900	0.519	0.399	1.873	1.748	1.354	3659
9	Sugarcane Tops	1.000	0.125	0.100	1.652	1.522	1.527	3639
10	Wheat Straw	0.990	0.150	0.145	1.562	1.437	1.412	3443
11	Cotton Ginning Waste (seed)	1	0.1	0.09	1.381	1.281	1.281	3147
12	Cotton Ginning Waste (cotton)	0.96	0.06	0.02	1.472	1.402	1.412	355 <mark>1</mark>
13	Cotton Ginning Waste (70% seed + 30% cotton) The Higher Calorific Value of the Cotton Ginning Waste was calculated on the basis of percentages of the seed & waste cotton, which were determined experimentally.						3268	

Results of CHNOS Analysis

S No	Name of Sample	С	Н	N	S	O
1	Banana Plant	38.31	5.35	0.39	0.10	33.18
2	Baggase	44.65	5.54	0.18	0.00	41.79
3	Canola	39.66	5.32	0.20	0.93	35.27
4	Cotton Stalks	42.84	5.63	0.08	0.42	36.20
5	Maize Cob	44.69	6.16	1.04	0.09	36.72
6	Rice Husk	36.85	5.55	1.70	0.22	30.30
7	Rice Straw	36.39	4.96	1.01	0.22	35.35
8	Saw Dust	44.39	5.94	0.41	0.12	35.16
9	Sugarcane Tops	39.92	3.72	0.15	0.14	40.03
10	Wheat Straw	40.83	5.34	0.83	0.24	33.80
11	Cotton Ginning Waste	39.87	5.06	1.70	0.60	27.47

CONCLUSION

- The study was carried out for the characterization, quantification and energy potential of waste agricultural biomass (WAB) for district Sanghar by taulka. The conclusion of the study is described below.
 - To know the current management practice, five questionnaires were designed.
- Total 1381 interviews were conducted, out of those 1180 were from farmers/ land lords, 39 from rice mills, 80 from wood mills, 60 from poultry forms and 22 from brick kilns.
- Data obtained from the field survey was analyzed critically to get status of each agricultural residue in each taulka of district and current WAB management system

CONCLUSION

- On the basis of field survey, total nine residues were identified for energy conversion and their total quantity was estimated, by taking cultivated area as reported by Crop Reporting Services Pakistan.
- About 43% of Total WAB is utilized for animal feed, in brick kiln and for cooking as a heat source
- About 57% WAB is available and its estimated quantity is available for energy conversion about 2533 kilo-tons.
- For characterization seven field residues (Banana Plant, Canola, Cotton Stalks, Maize Cob, Rice Straw, Sugarcane Tops and Wheat Straw) and four process residues (Baggase, Cotton Ginning Waste, Rice Husk, Saw Dust) were collected from district Sanghar and after processing as per standard they were analyzed for density, volatile and organic matters, calorific values and CHNOS.

