Trade Development Authority of Pakistan

Report on

Post Harvest Losses of RICE

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Introduction

Rice

Rice is the grain with the second highest worldwide production, after maize ("corn"). In Pakistan it's the 3rd largest crop in term of area after wheat and cotton.

By and large average rice yield in Pakistan comparatively low than China, USA, North Korea, South Korea, India, Bangladesh, Vietnam, Philippines, Brazil, Egypt, Iran, etc. It needs to increase in order to sustain food security at home and maintain our share in world markets. The quality of produce also suffers due to defective harvesting methods and out-dated processing technology and admixtures during various stages of processing and marketing.

Basmati is a premium long grain variety of rice, highly valued for its aroma and flavor and exclusively grown in certain parts of the Punjab. The adulteration of basmati rice with other cheaper varieties has become an area for potential exploitation. There is a need a develop a method that enables the differentiation of basmati varities from other long-grain rice in order to ensure consumer protection and for use in regulation of rice trade.

- The demand of parboiled rice is increasing day by day because **Parboiled rice** boiled in the husk and makes rice easier to process by hand, improves its nutritional profile, and changes its texture.

- Polishing rice by hand, that is, removing the bran layer is easier if the rice has been parboiled. It is, however, somewhat more difficult to process mechanically. The bran of parboiled rice is somewhat oily, and tends to clog machinery. Most parboiled rice is milled in the same way as white rice.

- Parboiling rice drives nutrients, especially thiamine, from the bran into the grain, so that parboiled white rice is 80% nutritionally similar to brown rice. Because of this, parboiling was adopted by North American rice growers in the early 20th century.The starches in parboiled rice become gelatinized, making it harder and glassier than other rice. Parboiled rice takes more time to cook, and the cooked rice is firmer and less sticky. In North America, parboiled rice is generally partially or fully precooked by the processor.

Trading in rice both in domestic and international markets has become more quality conscious. Even in the local markets buyers now demand quality rice. In order to meet the challenges under the WTO regime, it is now very essential for the country to put together its rice production and marketing strategies to match the demand of international markets.

Varieties of Rice grown in Pakistan

Pakistan produces varieties of rice, out of which following are the popular export varieties.

***Basmati*:**

1) Basmati 2000
2) Basmati – 385
3) Basmati – 198
4) Super Basmati
5) Basmati 370
6) Kernal
7) Shaheen (Basmati)

Rice Other Varieties

1) IRRI – 6
2) IRRI – 9
3) PG (IRRI)
4) KS 282
5) DR

Provincial Shares in Area and Production

The annual production of rice from 2006-07 to 2008-9 has an average of 5.984 million tones and area of 2679 thousand hectare. The provincial shares in area and production of rice by variety are as under

Provincial Shares in Area and Production of Rice
Average of 2006-07 to 2008-09

Variety	**Pakistan**		**Punjab**	**Sindh**	**NWFP**	**Balochistan**
Area	000 Hectare	Percent	Percent			
Total	2678.93	100	67.27	23.96	2.30	6.47
Basmati	1458.57	54.45	100	-	-	-
IRRI	880.55	32.87	18.76	61.54	-	19.69
Others	339.80	12.68	5245	2941	18.14	-
Production	000 tons					
Total	5983.93	100	55.50	34.28	2.12	8.10
Basmati	2502.47	41.82	100	-	-	-
IRRI	2692.67	45.00	15.50	66.51	-	17.99
Others	788.79	13.18	50.85	33.03	16.12	-

Source: Rice Export Association of Pakistan (REAP)

Above table shows that the average total rice production in Pakistan was 5984 thousand tons from 2006-07 to 2008-09 on a total area of 2679 thousand hectare. Basmati rice production was 2502 thousand tons on area of 1459 thousand hectare, IRRI was 2693 thousand tons on an area of 880 thousand hectare, and other Varieties of rice were 789 thousand tons on an area of 340 thousand hectare. The provincial shares of production of rice in percentage i.e. Punjab 56 %, Sindh 34 %, NWFP 2 %, and Balochistan 8 %.

<u>Short-term changes: 2007-08 and 2008-09</u>

The provincial changes in area, yield and production of rice for 2008-09 crop over 2007-08 crop are as under.

Area, Yield and Production of Rice by Variety: 2007-08 and 2008-09 Crops

Country/Province	**Area**			**Yield**			**Production**		
	2007-08	2008-09	Percent Change	2007-08	2008-09	Percent Change	2007-08	2008-09	Percent Change
	000 hect			Kgs/hect			000 tones		
Pakistan	**2515.4**	**2940**	**16.9**	**2212**	**2364**	**6.9**	**5563.4**	**6950**	**24.9**
Basmati	1377.1	1524.4	10.7	1781	1680	(5.7)	2453.1	2560.7	4.4
IRRI	827.1	947.6	14.6	2977	3309	11.1	2462.3	3135.4	27.3
Others	311.2	468.2	50.5	2083	2678	28.6	648	1253.9	93.5
Punjab	**1723.5**	**1954.2**	**13.4**	**1907**	**1843**	**(3.3)**	**3286**	**3601.3**	**9.6**
Basmati	1377.1	1524.4	10.7	1781	1680	(5.7)	2453.1	2560.7	4.4
IRRI	159.8	197.1	23.3	2593	2553	(1.5)	414.4	503.2	21.4
Others	186.6	232.7	24.7	2243	2309	2.9	418.5	537.4	28.4
Sindh	**594**	**733.5**	**23.5**	**3060**	**3510**	**14.7**	**1817.7**	**2574.7**	**41.6**
IRRI	531.1	560.3	5.5	3232	3549	9.8	1716.5	1988.5	15.8
Others	62.9	173.1	175.2	1609	3386	110.5	101.2	586.2	479.3
NWFP (others)	**61.7**	**62.4**	**1.2**	**2079**	**2087**	**0.4**	**128.3**	**130.3**	**1.5**
Balochistan (IRRI)	**136.2**	**190.1**	**39.6**	**2433**	**3385**	**39.1**	**331.4**	**643.7**	**94.3**

Source: Rice Export Association of Pakistan (REAP)

In 2008-09 the cultivation area of Rice was 2940 and production 6.9 million metric tons. The total production of rice at the country level increased by 24.9 percent solely due to 16.9 percent expansion in area and 6.9 percent improvement in yield. The production of basmati rice has increased by 4.4 % entirely because of expansion in area whereas the yield fell down by 5.7 %. The production of IRRI has increased by 27.3 % as a result of 14.6 % increase in area and 11.1 % improvement in yield. Similarly production of other varieties of rice has gone up by 93.5 % as result of 50.5 % increase in area and 28.6 % improvement in yield.

According to United States Department of Agriculture (USDA) Foreign Agricultural Service the World average rice yield in year 2009 is 4.25/MT/Hect, (Pakistan 3.45, Thailand 2.78, China 6.56, India 3.38, Bangladesh 4.01, Vietnam 5.05, Philippines 3.77, Egypt 10.04, Iran 3.95).

Analysis: Pakistan Rice Export for last five years

The below mentioned table presents an analysis of exports of rice from Pakistan for last five financial years in term of quantity, value and average unit price.

Value in `000` US$

	July - June											
	2009-10	**2008-09**	**% Change**	**2008-09**	**2007-08**	**% Change**	**2007-08**	**2006-07**	**% Change**	**2006-07**	**2005-06**	**% Change**
Rice												
Qty. M.T	4,014,487	2,729,360	**47.09**	2,729,360	2,809,148	**(3)**	2,809,148	3,129,142	**(10)**	3,129,142	3,688,742	**(15)**
Value	2,176,395	1,983,231	**9.74**	1,983,231	1,836,063	**8**	1,836,063	1,125,819	**63**	1,125,819	1,157,814	**(3)**
A.U.P. per M.T	542.14	726.63	**(25)**	726.63	653.60	**11**	653.60	359.79	**82**	359.79	313.88	**15**
Rice Basmati												
Qty. M.T	979,267	974,274	**0.51**	974,274	1,138,093	**(14)**	1,138,093	907,906	**25**	907,906	839,002	**8**
Value	855,976	1,070,338	**(20)**	1,070,338	1,068,862	**0**	1,068,862	556,320	**92**	556,320	479,616	**16**
A.U.P. per M.T	874.10	1,098.60	**(20)**	1,098.60	939.17	**17**	939.17	612.75	**53**	612.75	571.65	**7**
Rice Other Varieties												
Qty. M.T	3,035,220	1,755,086	**72.94**	1,755,086	1,671,055	**5**	1,671,055	2,221,236	**(25)**	2,221,236	2,849,740	**(22)**
Value	1,320,419	912,892	**44.64**	912,892	767,200	**19**	767,200	569,499	**35**	569,499	678,198	**(16)**
A.U.P. per M.T	435.03	520.14	**(16)**	520.14	459.11	**13**	459.11	256.39	**79**	256.39	237.99	**8**

Source: Federal Bureau of Statistics (FBS)

A.U.P of Thailand rice during last five years

Unit: USD per MT (milled basis)

Item	2010	2009	2008	2007	2006
Thai Hom Mali Rice Grade A (crop 2008/09)	1,105.46	923.57	936.37	570.64	480.70
Thai Hom Mali Rice Grade B (crop 2008/09)	1,089.50	908.42	920.06	556.18	467.57
Thai Hom Mali Rice Grade A (crop 2009/10)	1,006.26	963.36	920.00	578.35	494.67
Thai Hom Mali Rice Grade B (crop 2009/10)	990.40	948.11	904.12	563.77	483.58
Thai Hom Mali Broken Rice A.1 Super Special	591.55	603.08	701.56	365.49	311.66
Thai Hom Mali Broken Rice A.1 Super	434.90	495.61	593.63	311.69	242.56
Thai Pathumthani Fragrant Rice	777.70	767.09	784.20	421.02	398.05
White Rice 100% Grade A	602.85	631.71	720.73	371.83	340.53
White Rice 100% Grade B	536.92	584.38	697.73	336.17	313.44
White Rice 15%	476.83	510.90	647.16	317.37	290.35
White Rice 25%	445.99	458.86	604.51	305.06	270.36
Parboiled Rice 100%	540.02	616.76	726.55	340.69	309.54
Parboiled Rice 5%	536.83	613.68	723.41	337.86	306.54
Parboiled Rice 25%	524.33	601.63	710.71	326.12	297.95
Parboiled Broken Rice A.1	333.25	287.96	453.74	245.56	216.76

Remark - Above FOB prices not included packaging.
Source: Board of Trade of Thailand

A.U.P of Vietnam and India rice during last five years

Unit : US$ / tone, FOB

Month	Viet 5%	Viet 25%	India 25%
2005	255	239	236
2006	266	249	247
2007	313	294	292
2008	614	553	NA
2009	432	384	NA

Source: Rice Market Mornitor, FAO collected from Jackson Son & Co. (London) Ltd. and other public sources

World Rice Trade

Exporters

Unit: 1,000 MT

Country	2006	2007	2008	2009	2010	2011	%Change
Thailand	7,376	9,557	10,011	8,570	9,500	10,000	5.26
Vietnam	4,705	4,522	4,649	5,950	5,750	5,800	0.87
Pakistan	3,579	2,696	3,000	3,000	3,300	3,600	9.09
United States	3,260	3,003	3,219	2,992	3,300	3,350	1.52
India	4,537	6,301	3,383	2,150	2,200	2,500	13.64
Cambodia	350	450	500	800	850	900	5.88
China	1,216	1,340	969	783	850	900	5.88
Uruguay	812	734	742	926	750	800	6.67
Burma	47	31	541	1,052	600	700	16.67
Argentina	487	436	408	594	550	600	9.09
Brazil	291	201	511	591	300	500	66.67
Egypt	958	1,209	750	575	520	400	-23.08
Guyana	250	210	210	250	250	250	0.00
Japan	200	200	200	200	200	200	0.00
Ecuador	161	101	5	37	150	150	0.00
EU-27	144	139	157	150	140	140	0.00
Others	725	721	434	527	546	560	2.56
World Total	29,098	31,851	29,689	29,147	29,756	31,350	5.36

Source: World Market & Trade, USDA

Importers

Unit: 1,000 MT

Country	2006	2007	2008	2009	2010	2011	%Change
Philippines	1,791	1,900	2,500	2,000	2,600	2,500	-3.85
Nigeria	1,600	1,550	1,800	2,000	1,800	1,900	5.56
Iran	1,500	1,500	1,550	1,400	1,400	1,600	14.29
EU-27	1,221	1,342	1,520	1,383	1,350	1,350	0.00
Saudi Arabia	958	961	1,166	1,049	1,100	1,300	18.18
Iraq	1,306	613	975	1,089	1,100	1,150	4.55
Malaysia	886	799	1,039	1,070	1,020	1,020	0.00
Cote d'Ivoire	750	980	800	800	860	900	4.65
South Africa	800	960	650	745	800	850	6.25
Japan	681	642	546	750	700	700	0.00
Senegal	600	700	860	715	700	700	0.00
United States	633	695	651	682	735	700	-4.76
Mexico	585	607	578	610	600	650	8.33
Brazil	691	684	417	650	850	600	-29.41
Cuba	594	574	558	457	550	550	0.00
Vietnam	350	450	300	500	500	500	0.00
Hong Kong	309	348	399	395	400	410	2.50
Bangladesh	531	1,570	1,658	150	250	400	60.00
Guinea	200	240	175	150	330	375	13.64
Mozambique	330	410	300	350	350	375	7.14
Syria	214	235	230	300	350	350	0.00

Thailand	2	3	8	300	300	350	16.67
United Arab Emirates	250	285	300	300	300	350	16.67
Yemen	250	338	315	325	325	335	3.08
Canada	333	341	365	322	330	330	0.00
China	654	472	295	337	300	330	10.00
Others	11,079	12,652	9,734	10,318	9,856	10,775	9.32
World Total	29,098	31,851	29,689	29,147	29,756	31,350	5.36

Source: World Market & Trade, USDA

Notes:

All data are reported on a milled basis.

This table was prepared by the Grain and Feed Division, Commodity and Marketing Programs, Foreign Agricultural Service, USDA, Washington DC 20250. Information is gathered from official statistics of foreign governments and other foreign source materials, reports of U.S. agricultural attaches and Foreign Service officers, results of office research, and related information.

WORLD RICE PRODUCTION CONSUMPTION AND ENDING STOCKS

MILLLED PRODUCTION

Unit: 1,000 MT

Country	2006	2007	2008	2009	2010	2011	%Change
China	126,414	127,200	130,224	134,330	137,000	137,500	0.36
India	91,790	93,350	96,690	99,180	87,500	99,000	13.14
Indonesia	34,959	35,300	37,000	38,300	38,800	40,000	3.09
Bangladesh	28,758	29,000	28,800	31,000	31,600	32,300	2.22
Vietnam	22,772	22,922	24,375	24,393	24,312	24,750	1.80
Thailand	18,200	18,250	19,800	19,850	20,300	20,600	1.48
Burma	10,440	10,600	10,730	10,150	10,597	11,000	3.80
Philippines	9,821	9,775	10,479	10,753	10,100	10,800	6.93
Brazil	7,874	7,695	8,199	8,569	7,820	8,400	7.42
Japan	8,257	7,786	7,930	8,029	7,711	7,850	1.80
United States	6,912	6,088	6,149	6,400	6,917	7,621	10.18
Pakistan	5,547	5,450	5,700	6,700	6,500	6,500	0.00
Cambodia	3,771	3,946	4,238	4,520	4,780	4,950	3.56
South Korea	4,768	4,680	4,408	4,843	4,916	4,600	-6.43
Egypt	4,135	4,383	4,385	4,402	4,300	4,200	-2.33
Nigeria	2,700	2,900	3,000	3,200	3,400	3,600	5.88
Others	31,389	30,985	31,473	33,264	35,622	36,069	1.25
World Total	418,507	420,310	433,580	447,883	442,175	459740	3.97

Source: World Market & Trade, USDA

CONSUMPTION

Unit: 1,000 MT

Country	2006	2007	2008	2009	2010	2011	%Change
China	128,000	127,200	127,450	133,000	134,500	135,500	0.74
India	85,088	86,700	90,466	91,080	89,300	93,500	4.70
Indonesia	35,739	35,900	36,350	37,090	38,100	39,500	3.67
Bangladesh	29,000	29,764	30,747	31,000	32,000	33,000	3.13
Vietnam	18,392	18,775	19,400	19,000	19,150	19,500	1.83
Philippines	10,722	12,000	13,499	13,650	13,785	13,800	0.11
Burma	10,400	10,670	10,249	9,648	10,000	10,100	1.00
Thailand	9,544	9,780	9,600	9,500	9,600	9,800	2.08
Brazil	8,460	7,925	8,254	8,530	8,600	8,650	0.58
Japan	8,250	8,250	8,177	8,326	8,200	8,125	-0.91
Nigeria	4,300	4,400	4,500	5,150	5,300	5,500	3.77
South Korea	4,766	4,887	4,670	4,788	4,750	4,740	-0.21
United States	3,682	3,959	3,919	3,957	4,285	4,329	1.03
Cambodia	3,571	3,646	3,788	3,770	3,960	4,070	2.78
Egypt	3,320	3,276	3,340	4,000	4,000	4,000	0.00
Iran	3,274	3,294	3,297	3,400	3,500	3,600	2.86
Others	49,135	50,793	50,279	51,772	53,532	55,724	4.09
World Total	415,643	421,219	427,985	437,661	442,562	453,438	2.46

Source: World Market & Trade, USDA

ENDING STOCKS

Unit: 1,000 MT

Country	2006	2007	2008	2009	2010	2011	%Change
China	36,783	35,915	38,015	38,899	40,849	42,279	3.50
India	10,520	11,430	13,000	19,000	15,000	18,000	20.00
Indonesia	3,207	4,607	5,607	7,057	7,987	8,737	9.39
Thailand	3,594	2,510	2,707	4,787	6,287	7,437	18.29
Japan	2,395	2,406	2,556	2,715	2,726	2,951	8.25
Philippines	5,293	4,868	4,418	4,121	3,036	2,536	-16.47
Vietnam	1,317	1,392	2,018	1,961	1,873	1,823	-2.67
United States	1,338	1,234	918	960	956	1,605	67.89
Others	11,355	10,531	11,249	11,210	11,609	11,257	-3.03
World Total	75,802	74,893	80,488	90,710	90,323	96,625	6.98

Source: World Market & Trade, USDA

Notes:

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Rice Area Yield and Production

Country/Region	Area (Million hectares)				Yield (Metric tons per hectare)				Production (Million Metric tons)			
			2010/11 Proj.				2010/11 Proj.				2010/11 Proj.	
	2008/09	Prel. 2009/10	Jul	Aug	2008/09	Prel. 2009/10	Jul	Aug	2008/09	Prel. 2009/10	Jul	Aug
World	157.83	155.07	160.04	160.13	4.25	4.27	4.3	4.29	448.03	442.61	459.28	459.17
United States	1.2	1.26	1.41	1.41	7.68	7.94	8.02	7.89	6.4	6.92	7.81	7.68
Total Foreign	156.63	153.81	158.63	158.71	4.22	4.24	4.26	4.26	441.63	435.7	451.47	451.49
East Asia												
China	29.24	29.68	29.8	29.8	6.56	6.59	6.59	6.59	134.33	137	137.5	137.5
Japan	1.63	1.62	1.62	1.62	6.78	6.52	6.66	6.66	8.03	7.71	7.85	7.85
Korea South	0.94	0.92	0.9	0.9	6.99	7.19	6.91	6.91	4.84	4.92	4.6	4.6
Korea North	0.59	0.59	0.59	0.59	4.89	5.02	5.05	5.05	1.86	1.91	1.92	1.92
South Asia												
India	45.4	41	45	45	3.28	3.26	3.3	3.3	99.18	89.13	99	99
Bangladesh	11.1	11.6	11.7	11.8	4.19	4.01	4.14	4.11	31	31	32.3	32.3
Pakistan	**2.91**	**2.8**	**2.8**	**2.8**	**3.45**	**3.48**	**3.48**	**3.48**	**6.7**	**6.5**	**6.5**	**6.5**
Southeast Asia												
Indonesia	12.17	12	12.2	12.2	4.88	5.01	5.08	5.08	38.3	38.8	40	40
Vietnam	7.33	7.37	7.35	7.35	5.3	5.29	5.39	5.39	24.39	24.38	24.75	24.75
Thailand	10.8	10.94	11	11	2.78	2.81	2.84	2.84	19.85	20.3	20.6	20.6
Burma	6.7	7	7.1	7.1	2.61	2.61	2.67	2.67	10.15	10.6	11	11
Philippines	4.53	4.4	4.45	4.45	3.77	3.52	3.85	3.85	10.75	9.76	10.8	10.8
Cambodia	2.61	2.68	2.75	2.75	2.75	2.84	2.77	2.77	4.52	4.78	4.8	4.8
Laos	0.83	0.84	0.86	0.86	3.54	3.61	3.68	3.68	1.76	1.82	1.9	1.9
Malaysia	0.66	0.67	0.67	0.67	3.58	3.68	3.7	3.7	1.54	1.59	1.6	1.6
South America												
Brazil	2.91	2.76	2.85	2.85	4.33	4.07	4.33	4.33	8.57	7.64	8.4	8.4
Peru	0.38	0.4	0.39	0.39	7.35	7.4	7.44	7.44	1.93	2.06	1.98	1.98
Sub-Saharan Africa												
Nigeria	2.3	2.4	2.45	2.45	2.32	2.36	2.45	2.45	3.2	3.4	3.6	3.6

Madagascar	1.36	1.38	1.38	1.38	2.88	3.05	3.05	3.05	2.51	2.69	2.69	2.69
EU-27	0.41	0.46	0.47	0.47	6.16	6.81	6.73	6.73	1.62	1.98	2.01	2.01
Italy	0.22	0.24	0.24	0.24	5.99	6.65	6.66	6.66	0.82	0.96	0.98	0.98
Spain	0.1	0.12	0.13	0.13	6.63	7.55	7.31	7.31	0.45	0.63	0.65	0.65
Egypt	0.67	0.67	0.6	0.6	10.08	9.87	10	10	4.4	4.3	3.9	3.9
Iran	0.58	0.63	0.63	0.63	3.95	4.85	4.93	4.93	1.5	2	2.05	2.05
Others	10.59	11.02	11.09	11.08	3.01	2.99	3.01	3.01	20.7	21.43	21.73	21.74

Source: World Market & Trade, USDA

Yield is on a rough basis, before the milling process
Production is on a milled basis, after the milling process Yield is on a rough basis, before the milling process
Production is on a milled basis, after the milling process

Factors of high exports of rice from Thailand, India, and Vietnam

Production and Consumption

One of the main reasons of high exports of rice from Thailand, India, and Vietnam are that the Production is more than the local consumption. The difference of production and consumption of Thai rice is 10,350 thousand MT, the difference of production and consumption of Vietnamese rice is 5,388 thousand MT, and difference of production and consumption of Indian rice is 8,100 thousand MT in year 2008/09.
On the other hand Pakistan is on rank 12 in world rice production and the total production is 6,700 thousand MT, in which around 3,500 thousand MT tons are available for export purposes.

Technology, cultivation and Harvesting

Thailand and India is more advance in technology and skilled labor. Pakistan is still using the traditional method of cultivation and harvesting due to which the production is of low quality and 20 to 30 percent losses of post harvesting.

Parboiled Rice

The demand of parboiled rice is increasing day by day because **Parboiled** boiled in the husk and makes rice easier to process by hand, improves its nutritional profile, and changes its texture.

Veitnam is not producing parboiled rice. Thailand and India is producing parboiled rice according to the demand in the international market. Pakistan is also producing parboiled rice but in small quantity and can't meet the international demand.

Price

Veitnamese Rice is more cheeper than Thai and Pakistani Rice. Due to which the demand of veitnamese rice is more than Thai and Pakistani rice. The government of Vietnam strictly control the prices as well sign government to government agreement with major importing countries. Currently because of Vietnamese rice Pakistan and Thailand is facing the low price issue in the international market. Thailand Ministry of Commerce watch over rice demand and supply in world market and release and stop their stocks to balance demand and supply of rice.Thai & Vietnamese rice is edge over the Pakistani rice because being of member of ASEAN and availing the benefits of biletral trade. It is also noted that due to poor marketing strategy Pakistani Basmati rice is not aquiring the right value in the international market and Pakistani exporters have no price mechnism, they export rice on cheaper price if they bought rice cheap in the local market.

Supply Chain Issues:

- Lack of supplies of certified seeds.
- To aquire the desired number of plants per acre, skilled labor is not engaged for transplanting of nursery under strict vigilance.
- Lining of irrigation canals, distributaries and on-farm water channels are not properly managed.
- Power tariffs are on higher side which makes the tube-well irrigation expensive.
- Proper machinery is not being used by the farmers in harvesting and threshing, which results in damage to the quality of rice.
- The storage capacities for exports are in sufficient.
- Prices of fertilizers and pesticides are on higher side.
- Old traditional system to dry the paddy rice on open space is still in practice.
- Lack of marketing strategy and price mechanism.

Note: Exemption of customs duty and sales tax on rice processing machinery to boost value addition and export of rice, announced in Budget 2010-11.

Post-Harvest Losses

The rice post-harvest system requires improvement in the use of resources for research and development, particularly with regard to the level of post-harvest losses. These losses are attributed to a combination of factors during production and post-production operations.

This paper presents an overview of the main post harvest operations traditionally used by rice farmers in developing countries and the importance of post-harvest technologies for minimizing rice losses. Inadequately performed drying and storage operations contribute to increased losses. The advantages of the household metallic silo are discussed and it is proposed as a feasible and suitable alternative - highly recommended by FAO - for small and medium rice farmers. While this study does not address drying operations in detail, it should be noted that they are complementary to storing.

Post-harvest system

The post-harvest system consists of a set of operations which cover the period from harvest through to consumption. An efficient post-harvest system aims to minimize losses and maintain the quality of the crop until it reaches the final consumer. When food losses are minimized, both food security and income increase, and this are of vital importance for small and medium farmers, particularly in developing countries. From a socio-economic point of view, the implementation of an efficient post-harvest system in any community must provide equitable benefit to all those involved in the system.

Post-harvest losses

The traditional concept of post-harvest losses - for the main part quantitative losses - is currently changing. Many post-harvest specialists recognize that measurement of post-harvest losses is a very relative concept for various reasons; for example, losses could be determined as a function of theoretical yield, real yield, soil and fertility conditions, variety etc. Then there are the other losses which are not normally measured, such as agricultural inputs, time, manual labor, lost opportunities etc. In spite of the above, when post-harvest losses are assessed - whether in grains, cereals, fruits or vegetables - the most practical approach (and therefore the norm) continues to be quantitative measurement. To obtain reliable data of post-harvest losses, it is nevertheless important to establish a methodology which takes into account a range of factors (cultivar size, plot size etc.). Data should be supported by basic statistical analysis in order to understand how efficiently a post-harvest system works.

The post-harvest system for rice deserves special attention: rice is a major staple food in the world and is mostly produced in developing countries where the implementation of post-harvest technologies is urgent in order to prevent food rice losses. It has been estimated that rice post-harvest losses may be as high as 16 percent. A study carried out in China revealed that total post-harvest losses ranged from 8 to 26 percent, with storage and drying the most critical operations.

Main post-production operations used by rice farmers

Paddy pre-harvesting operations

The quantity and quality of final milled rice depend on the efficiency of farming management, field operations and post-harvest operations. Decisions are taken from planting through to consumption of the rice crop. Initial decisions about the variety to be planted determine intrinsically desirable characteristics and depend upon consumer preference as well as the technical capacity of the farmers during production and post-production operations. These characteristics in turn become factors which influence efficiency, grain loss magnitude, choice of harvesting and threshing technology, rate and quality of the drying and dehusking process, and eventually total recovery of the milled rice. Then there are the wrong practices at the planting stage which can lead to losses: planting of red rice admixture, attacks by rodents and birds, poor weeding and a harvest maturity date which can be too early or too late.

It is important to point out that the differences in varieties planted in certain localities also affect the final milled rice, as the high-value rice market usually prefers a pure and single variety. Nevertheless, for reasons of biodiversity and more sustainable agriculture, planting different varieties (although not necessarily in the same field) is an excellent strategy for improved food security. Sometimes, high management is required to monitor planting in order to prevent varieties becoming mixed; on the other hand, varieties are sometimes deliberately mixed to produce special characteristics, such as consistency of flavor, which cannot be found in a pure variety.

During pre-harvest operations, efficient technology and input management, as well as timeliness of activities, are important, and this applies also to post harvest operations for good yield and quality and in order to obtain good prices for the milled rice and byproducts. Correct timing at harvest is essential to avoid losses incurred by harvesting too soon or too late. Immature grains harvested too early result in a high percentage of broken and low milling recovery, while if harvesting is delayed, the crop is exposed to insects, rodents and birds, in addition to the risks of lodging and shattering. The optimum harvest time should be chosen depending on the variety planted.

In general, the correct time to harvest is 1 week before the maturity date.

Others indicators for optimum harvesting time for rice are as follows:

- When the rice has reached the exact date of maturity or numbers of days after heading (usually 28-34 days).
- When 80 percent of the grains have changed from green to straw color.
- When at least 20 percent of the grains at the base have a hard dough stage.
- When the grain moisture content is between 21 and 24 percent.
- When the hand-dehulled grain, as indicated by daily tests near the projected harvested date, is clear and hard.

Harvesting

Harvesting includes numerous operations, including: cutting the rice stalk; reaping the panicles; laying out the paddy-on-stalk or stacking it to dry; and bundling for transport. Correct harvesting and handling operations can considerably reduce post-production losses. Excessive handling creates problems in terms of both quality and quantity.

The sequence of manual harvesting, field drying, bundling and stacking in traditional systems can cause losses of between 2 and 7 percent. At this stage, losses can occur when secondary tiller panicles are missed when the sickle cuts 60 cm above ground in lowland rice. Also, delayed harvest causes shattering losses during harvesting and transport.

Harvesting methods

There are a variety of different methods for rice harvesting, with traditional manual methods prevailing in developing countries:

Panicle reaping

This is accomplished by using a hand-held cutting tool (*Yatab* in the Philippines, *Ani-ani* in Indonesia, *Kae* in Thailand, *Espigadora* in Bolivia). The method is used in areas where traditional varieties are resistant to shattering. Resistance to shattering is particularly important during handling and when transporting the bundles of panicles from field to house. The labor time required for this method is 240 labor-hours/ha (done mostly by women and older children), which is four times that required with the hand-sickle method. It remains popular because of the social custom of chatting while working. In addition, it generates income among the landless rural population and is suitable for hilly and terraced areas.

Long stalk cutting by sickle

This is a widely used manual method presenting different styles in the design. It requires between 80 and 180 labor-hours/ha. The stalk is cut about 10 to 15 cm above the ground or with a stalk length of about 60 to 70 cm for easy bundling and threshing. Reaping efficiency depends on various cultural practices, plant density and variety, degree of lodging, soil conditions and the skill of the harvester. Lodged paddy and saturated soils may considerably reduce the cutting rate.

Modern mechanical methods

These methods are generally used when labor is scarce; otherwise, harvesting is generally still done with a sickle in most developing countries. The use of mechanized harvesting methods in some areas depends upon the custom and suitability of the machine and other socio-economic factors. Some examples of these machines are:

- Reaper binder: once very popular, it is currently being replaced by the combine. The machine cuts and bundles stem together and lay them in the field in a single operation.
- Combine: very popular, its adoption in Japan, Korea and other Asian countries is slow only because of its high cost. The binder can harvest 0.05 ha/hour. A similar, large model was developed in Thailand to resolve the problems of scarcity and cost of labor; Viet Nam may also adopt mechanized methods because of economies of scale. Some other Asian countries import second-hand, large combines for harvesting the basic rice crop. In commercial rice production, large combines are generally used in countries such as Brazil and Uruguay in Latin America, in Europe and in the United States of America. In Africa, on the other hand, these machines (introduced through international aid programmes) have had little impact because of the lack of maintenance facilities.
- Stripper harvester: an innovation from IRRI and an adaptation of the rotary stripping combine principle developed by Silsoe Research Institute in the United Kingdom, it works with varieties which are non-lodging, medium height, with erect panicles and low to medium shattering.

There continue to be constraints for farmers in developing countries to the adoption of mechanical harvesting methods: low income, reluctance to move away from traditional methods, poor mechanical aptitude, the desire to save straw for off-farm uses, lack of access to the field, excessive moisture content, uneven ripening etc. Other limiting factors are the high cost of imported equipment and the fact that machinery management must be competitive with the relatively low cost of labor.

Transport

In developing countries, transportation of paddy from the field to processing areas is performed mainly by humans and animals, and sometimes using mechanical power. These traditional methods of transport, which are related to the harvesting and field drying activities, very often result in high grain losses. Small and family-sized volumes of paddy are generally transported in bags from the house storage to the small rice mill on foot, in bullock carts, by bicycle, using small vehicles or with public transport - whatever means is available and affordable. Other methods of transport include donkey, buffalo and even boat.

In some places, the practice is to windrow the cut paddy in the field to dry for 3 to 7 days, depending upon the weather conditions. Losses are even greater, especially if harvesting is delayed with respect to the crop maturity date. In addition to the losses incurred in cutting, wind-rowing, sun-drying, collecting and bundling of the cut crop, there are those when the bundled paddy-in-straw is loaded onto the person’s back to be carried to the house.

Grain then falls en route, especially with the transportation of shattering varieties, and also when the carrier (usually a woman) stops to rest. Nevertheless, some farmers prefer this method for both cultural and practical reasons, as the straw can be used as animal feed.

The large losses incurred are the principal drawback to manual transport. Threshing of the paddy in the field and transportation in bags (40-75 kg) can minimize grain losses, however. Sun-drying of the paddy can also be done in the yard of the house rather than on stalks in the field. The normal practice in Asia is to bring the paddy from the field to the roadside manually or using animal power; it is then transported to the drying area or rice mill by motor vehicle (e.g. tricycle, power tiller with trailer, tractor with trailer, truck or lorry). The loading and unloading of the bags require additional labor costs, and these are normally assumed by the buyer.

In developing countries and advanced developing countries, the paddy is harvested by combine and is handled and transported in bulk. The paddy is unloaded from the combine by an auger conveyor and loaded into a waiting lorry or tractor-trailer located on the field road (part of the infrastructure for mechanized rice production). The paddy is then unloaded from the lorry or trailer onto a floor hopper in the rice mill area to be conveyed to a mechanical dryer. Finally, commercial rice is bagged at the rice mill and normally transported to wholesale and retail markets by means of vehicles. This mechanized procedure results in much lower losses.

Threshing

During threshing the paddy kernel is detached from the panicle, an operation which can be carried out either by “rubbing”, “impact” or “stripping”. Rubbing may be done with trampling by humans, animals, trucks or tractor; however, the grain becomes damaged. Mechanical threshers adopt mainly the impact principle, but there is also a built-in stripping action.

With a paddy thresher, the unthreshed paddy may be either held or thrown in. In the “hold-on” type, the paddy is held still in the cylinder while spikes or wire loops perform impact threshing. In a “throw-in” machine, whole paddy stalks are fed into the machine and a major portion of the grain is threshed by the initial impact caused by bars or spikes on the cylinder.

In a conventional threshing cylinder, stripping may also be used for paddy threshing; impulsive stripping normally occurs with impact threshing. In a throw-in thresher, large amounts of straw pass through the machine and some designs use straw walkers to initially separate the loose grain from the bulk of the straw and chaff.

International Rice Research Institute (IRRI) Philippines developed the Votex Ricefan thresher. A portable machine, suitable for both paddy panicles and paddy stalks, it may be adapted for wheat, corn, soybean and beans. The Votex Ricefan thresher has been widely accepted among Bolivian paddy farmers (Terán, 1996) and may be either manually or power-operated.

Manual threshing is pedal-operated and involves: treading; beating the panicles on a tub, threshing board or rack; or beating the panicles with a stick or flail device. The thresher consists of a rotating drum with wire loops which strip the grain from the panicle when the paddy is fed by hand. This equipment is portable, can be used in hilly areas and is easily operated by women.

In power threshing, the harvested crop is trampled by tractor or truck tyres in developing countries. The grain is separated from the straw by hand and then cleaned by winnowing.

Losses may occur during threshing for various reasons:

- In manual threshing by beating, some grains remain in the bundle panicles and a repeat threshing is required.
- Grain is scattered when the bundles are lifted just before threshing.
- Grain can stick in the mud floor.
- Birds and domestic fowls feed on the grain.

Drying

Paddy as a living biological material absorbs and gives off moisture depending on: paddy moisture content, relative humidity of the air and temperature of the surrounding atmosphere. The respiration of the paddy is manifested in various ways: decrease in dry matter weight; utilization of oxygen; evolution of carbon dioxide; and the release of energy in the form of heat. However, respiration is negligible when the moisture content is between 12 and 14 percent.

By and large, paddy is harvested with moisture content of 24 to 26 percent (higher in the rainy season and lower in the dry season). It has a high respiration rate and is susceptible to attacks by micro-organisms, insects and other pests. The heat released during the respiration process is retained in the grain and in the bulk due to the insulating effect of the rice husk, resulting in losses in terms of both quantity and quality. Therefore, harvested grain with high moisture content must be dried within 24 hours: to 14 percent for safe storage and milling, or at most 18 percent for temporary storage of 2 weeks when it is not possible to dry any faster. Delayed drying may result in non-enzymatic browning (stack-burning), microbial growth and mycotoxin production in parboiled rice.

Losses due to bad drying practices range from 1 to 5 percent and it is mainly the quality which is affected. Good drying is crucial for minimizing post-harvest losses, since it directly affects safe storage, transportation, distribution and processing quality.

A temperature of 43°C is recommended for drying paddy for seeds and this can be achieved with shade drying. Higher temperatures can lead to physicochemical disorders in the grain. The cheapest drying method is sun- or solar drying, practiced by farmers, cooperatives, commercial millers and government grain agencies in most developing countries. Between 70 and 90 percent of the field harvest retained in the farm is sun-dried, with the work generally performed by women and children. Drying usually takes place on paved areas next to the warehouse and rice mills; the paved areas slope slightly so that water can drain away during the rainy season.

Early harvesting when moisture content is high helps minimize shattering losses in the field. In crops of high-yielding varieties it is necessary to dry large quantities of wet grain in the shortest time so as to minimize rice spoilage. An artificial or mechanical dryer speed up the drying process, reduces handling losses, maintains grain quality and gives better control during drying.

The temperature for drying paddy should not be higher than 54.4°C for food grain using the dry batch system. Low temperatures help preserve the rice aroma principle 2-acetyl-1-pyrroline.

The choice of a drier system depends on several factors: drying capacity requirement, ease of installation and operation, portability, full heat source and the initial cost of purchase. A wide range of drying equipment and methods are available for rough rice, and computer models have been developed to assist agricultural research workers or farmers in their selection of dryers for a given crop and situation.

The adoption of an artificial drying system by rice farmers has numerous constraints:

- High fuel costs.
- Small farmers producing a small volume of paddy can easily use sun-drying.
- It is popular belief that the bleaching effect of sun-dried paddy results in whiter grains than artificially dried paddy.
- Lack of capital for investing in artificial dryers.
- Lack of know-how about the drying technology.

The main causes of losses during drying are as follows:

- Grains shattering from stalks or spilling out from bags during transport.
- Birds and domestic fowls.
- Spill-out outside the drying area.
- Over-drying, especially during sun-drying.
- Delayed drying or no grain aeration, resulting in stack-burning.

Paddy cleaning

This is an important operation and highly recommended not only on a large and medium commercial scale, but also on a small scale. It consists of the separation of undesirable material, such as weed seeds, straw, chaff, panicle stems, empty grains, inmate and damaged grains, sand, rocks, stone, dust, plastic and even metal and glass particles. The degree of cleanness of the paddy reflects to some extent the care applied during harvesting, threshing and handling.

In developing countries, farmers clean the paddy straight after manual threshing. First, they use hand-raking and sifting to remove straw, chaff and other large and dense materials, then winnowing, i.e. making the grain fall down to be collected on a surface such as tarpaulin or a nylon sheet. The method depends on air natural conditions and is very slow.

A versatile model from IRRI, known as “GC-7” and with a capacity of 1 t/hour for paddy and 3 t/hour for maize, was widely accepted by Bolivian farmers. The main advantage of this model is that it can be manufactured in developing countries in local metal workshops.

Cleaned paddy demands a higher price than non-cleaned paddy - an incentive for cleaning the paddy. In contrast, lack of cleaning often results in a higher concentration of contaminants in the milled rice. Another consideration is that stones and other hard particles shorten the life of the milling equipment. Finally, milling recovery is low when paddy is not cleaned.

Storage

Paddy may be produced once a year or throughout the year. Consequently, it is important to improve and expand the post-harvest infrastructure for better handling, processing and storage of the paddy. Storage is a critical operation and losses can easily occur if preventive measures are not taken.

In Asia, between 70 and 90 percent of farm-produced paddy remains in the farms and the rest is deposited in or sold to agricultural cooperatives or sold to the private sector. Appropriate storage is therefore required, both for rice for consumption (milled or paddy) and for rice for seed purposes. The storage structure must protect the paddy from: extreme heat or cold; moisture, which causes microbial and fungal growth; and insect pests and rodents which consume or damage the rice.

The main causes of losses during storage are:

- Attack by insects, rodents and birds as a result of inadequate protection.
- Long-term storage with 14 percent or higher moisture content, or more than 2 weeks' storage with 18 percent moisture.
- Theft and pilferage in the warehouse.

Milling

Paddy or the rice grain consists of the hull or husk (18-28%) and the caryopsis or brown rice (72-82%). Brown rice consists of: an outer layer (pericarp, tegmen and aleurone layers) called bran (6-7%); the germen or embryo (2-3%); and the edible portion (endosperm 89-94%). The rice milling operation is the separation of the husk (dehusking) and the bran (polishing) to produce the edible portion (endosperm) for consumption. Although a theoretical mill recovery would be between 71 and 73 percent, in practical terms it is possible to obtain between 68 and 70 percent from a good variety of paddy. Milling losses can be reduced by adopting small-scale modern rubber roll sheller and introducing parboiling of paddy before milling. The below table shows the advantages and disadvantages of parboiled rice.

Some advantages and disadvantages of parboiled rice

Advantages	Disadvantages
Milling or dehusking is easier and costs less	Bran removal is more difficult and costs more
Milled rice has fewer broken and is nutritious	Cannot be used in starch-making or brewing
Increased head and total rice out-turn	Doubles the total processing cost
Rice is more resistant to storage insect pests	Rice easily becomes rancid
Bran contains more oil	Requires large capital investment
Less starch lost in cooking and keeps longer	

Causes of losses during milling include:

- Incorrect adjustment of milling equipment;
- Spillage in traditional hand-pounding; and
- Under- or over-dried paddy.

Post-harvest losses

As mentioned previously, "loss" is a concept which is difficult to define. Quantitative losses, however, eventually provide a broad picture of where the losses occur and their relative scale, and how a specific crop is handled during post-harvest operations. Losses are estimated on the basis of the post-harvest losses in each stage and assuming that each loss found is a percentage of the amount remaining from the previous stage. Otherwise, if losses are determined on the basis of the original weight of the crop, the figure may be overestimated.

The below table shows the results of a study carried out by FAO in 1994 on total post-harvest losses in six rice country projects in Asia.

Comparison of total recorded project losses

Operation	Sri Lanka	Thailand	Myanmar	Indonesia	Bangladesh	Nepal
Cutting	0.86	10.1	2.1	0.8	2.3	1.9
Field drying (including bundling)	0.5	1.2	0.4		0.7	1.9
Transport		1.2	0.4	-	0.5	0.5
Stacking, pre-threshing	2.8	1.4				
Threshing (including cleaning)	0.5	0.9	0.4	-	1.4	2.2
Drying	-	-	-	2.9	2.3	1.6
Parboiling					1.9	-
Storage	7.5	-	-	3.2	0.9	6.3
Milling	-	-	-	4.4	3.8	4.4
Average total losses	**12**	**14.6**		**12.2**	**13.2**	**16**

It may be inferred that total post-harvest losses average around 14 percent, while the average losses in storage alone are around 4.5 percent. In fact, poor storage practices are one of the main causes of losses in the various stages of the post-harvest system. In Pakistan is also observed that post harvest losses are mainly because of impropriate storage capacity.

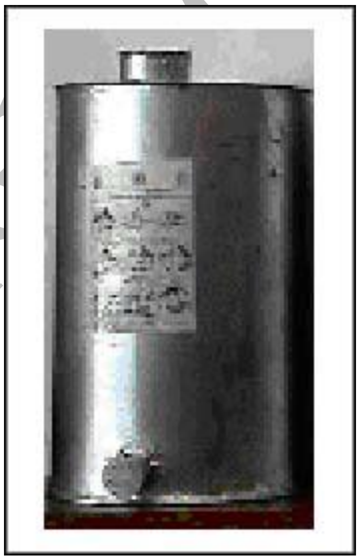
STORAGE POST-HARVEST LOSSES

As storage is one of the most critical post-harvest operations, it deserves special attention in order to estimate the economic magnitude of its negative impact.

A technology for rice loss prevention in-store: household metallic silo

A valuable structure highly recommended by FAO for small and medium rice farmers is the small metallic silo (Plate 1). The small metallic silo can play an important part in the fight for food security and against hunger in developing countries. Its effectiveness for safe storage has been proven since the 1980s. The technology was introduced as part of the Swiss cooperation for development in Central America, since when more than 230 000 small metallic silos with a capacity of between 0.5 and 2 tones have been introduced to prevent food loss. It has been estimated that more than 2 million people currently benefit from this technology in Central America. An FAO project in Bolivia on the prevention of food losses, has successfully introduced more than 20 000 small metallic silos in the last 5 years.

PLATE 1
A silo



Source: FAO, 2002.

CONCLUSIONS AND RECOMMENDATIONS

- Import of rice harvesters without duty is allowed from any country of origin.
- Harvesting of immature paddy to be discouraged with punitive action.
- Information on proper harvesting, methods and its importance must be added to the awareness program.
- Imported and locally manufactured Paddy dryers must be given relief in taxes, levies and duties to meet the needs of millers all over Pakistan.
- Millers are encouraged to install parboiled rice units to meet the demand of parboiled rice in the world.
- To promote rice exports, the storage capacity at the export point should be enhance.
- Proper system of disbursement of private sector credit for Rice exporters may be developed.
- Ministry of Food and Agriculture Islamabad may be requested to seek technical advice from International Rice Research Institute Philippines for increasing production yield/Hectare of rice in Pakistan.

- Rice post-harvest losses are high in developing countries (14-16%) in Pakistan up to 30%.
- Suitable technologies are required to reduce post harvest losses.
- Storage is a critical operation for rice, representing between 4 and 6 percent of total post-harvest losses.
- The small silo technology is a feasible and valuable alternative highly recommended by FAO for small and medium rice farmers to prevent food losses.
- The impact of this technology causes a positive socioeconomic and critical mass effect in agricultural communities.
- FAO has positive experience in the transfer of the silo technology through the Training for Trainer programme.
- The drying operation is considered critical during post-harvest and it is complementary to storage; resources and efforts must therefore be used to implement this technology, particularly in humid areas.
- The government with coordination with Rice Export Association may develop a price mechanism to get high price in the international market.

References:

- Rice Exporters Association of Pakistan (REAP)
- Thailand Rice Exporters Association
- Federal Bureau of Statistics
- International Trade Centre
- Food and Agriculture Organization
- United States Department of Agriculture