Variability of Head Rice Yield and Hardness Index of Different Philippine and IRRI Rices

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Introduction

- Head rice yield is a very important physical quality of commercial rice
- In the Philippines, broken grain is about ½ the value of whole milled rice (NFA, 2003)
- Head rice are those with length not less than ¾ the full length of the grain (NFA, 2003)
- Head rice yield is affected by variety, cultural practices, moisture content, drying and storage conditions

Head rice yield determination

- Official test method for determining milling quality requires 1 kg of paddy for each measurement (USDA, 1976)
- Modification using 150 g of paddy (Lu & Seibenmorgen, 1995)
- Kett Polisher Pearlest requires 10g sample (www.kett.co.jp)
- Digital image analysis using artificial neural network (www.foss.us)

Head rice yield vs physical properties

- Goodman & Rao (1985) studied the effect of grain type and milled rice kernel compression on HRY and reported r=0.22
- Webb (1986) studied the relationship of hardness to milling, cooking & processing characteristics and reported either low or insignificant correlations
- Lu & Seibenmorgen (1995) indicated that compressive strength is not a good indicator of HRY. They recommended the use of bending strength

Head rice yield vs 3-pt bending

- Khostaghaza (2001) reported HRY is highly correlated with bending strength
- Zhang et.al. (2005) also reported that bending strength of fissured grains decreased with longer drying time
- Bautista et.al. (2007) reported a correlation r=0.51 between breaking force and HRY. They also used the concept of strong kernel index (>20N force)

Objectives

- Correlate head rice yield (unstressed, stressed, Hampas) of selected Philippine and IR varieties with hardness indixes (3pt bending and Kiya breaking hardness)
- Determine the suitability of using stressed grain for head rice yield and Hampas method as an alternative methods of determining head rice yield

Rice varieties used

	Variety	Developed by	Environment	Grain L/S	AC	MR, %	GT
1	PSB Rc 50	IRRI	Saline prone	L/S	I	64.0	H
2	PSB Rc54	IRRI	Irrig lowland	M	I	70.0	H
3	IR 42	IRRI	Irrig lowland	L/S	H	63.5	L
4	PSB Rc72H	IRRI	Irrig lowland	L	L	68.7	L
5	PSB Rc30	IRRI	Irrig lowland	L/S	I	64.3	H
6	PSB Rc62	PhilRice	Rainfed lowland	M	I	64.3	H
7	PSB Rc14	UPLB	Rainfed lowland	L/S	I	65.8	I
8	PSB Rc52	IRRI	Irrig lowland	M	I	66.7	H
9	PSB Rc36	PhilRice	Rainfed lowland	M/I	H	62.5	I
10	PSB Rc38	PhilRice	Rainfel lowland	M/I	H	62.5	I

Unstressed head rice yield

- Ten (10) grams paddy was dehulled using a Satake TH35 rubber roll huller
- Five (5) grams whole brown rice was separated from the brokens and polished using a Kett Pearlest mill for 1 minute
- Head rice yield on rough rice basis

Stressed head rice yield

- Ten (10) grams paddy soaked in 30°C water for 1 hour and air-dried (30°C) for two days
- The dried paddy dehulled in Satake TH35 rubber roll huller
- Five (5) grams of brown rice was milled in a Kett Pearlest mill for 1 min
- Juliano (1993) noted that results from stressed analysis are more reproducible compared with unstressed analysis

Hampas method

- Ten (10) grams paddy manually dehulled and whole brown rice separated
- Whole brown rice in cheesecloth bag hit 50 times on hard surface

Three-point bending test

- Instron UTM Series 4411
- Series IX Software measuring breaking force of grain
- 20 brown rice kernels dehulled by hand and tested
- Distance bet supporting points is 3 mm
- Rectangula probe has rectangular width of 1 mm
- Crosshead speed at 1.25 mm/min (ASAE standards 1995)

Kiya crushing hardness

- 20 brown rice samples for each variety
- Grain placed on the platform while cylindrical crosshead exterted load on top of grain
- Probe surface area of 0.49 cm2

Variety	Head rice yield, %		Hampas head rice yield, %		3pt bending hardness, kg	Kiya breaking hardness, kg/cm2
	Unstressed grain	Stressed grain	Rough rice	Brown rice		
PSB Rc50	50	**17±2**	48±0	24±2	0.90±0.25	5.6±1.1
Burdagol 06WS	36	21±4	16±0	16±4	0.82±0.14	4.8±0.9
PSB Rc54	54	24±16	59±0	38±0	0.93±0.15	6.3±1.2
IR42	57	25±22	66±0	47±1	**0.72±0.10**	5.9±1.2
PSB Rc72H	46	26±6	43±0	26±6	0.80±0.19	5.8±1.4
IR64	47	27±8	46±1	44±1	0.77±0.16	6.8±1.0
PSB Rc30	49	29±0	54±1	40±1	0.99±0.16	5.7±1.3
PSB Rc62	56	32±6	59±0	36±2	0.77±0.17	7.7±1.3
PSB Rc14	42	34±11	54±1	42±2	0.94±0.19	6.8±1.7
IR60	56	37±14	62±2	54±5	0.86±0.16	6.3±1.0
PSB Rc10	60	39±15	56±2	44±2	0.73±0.17	5.9±1.2
PSB Rc52	56	43±4	60±1	40±3	1.08±0.18	6.3±1.1
PSB Rc36	55	46±10	62±1	42±1	0.90±0.13	6.8±1.0
IR2071-137-5	60	54±1	64±1	56±2	1.22±0.20	7.2±1.3
PSB Rc38	53	**56±1**	64±1	40±1	0.98±0.12	6.8±1.1

Head rice yield and bending hardness

		Head Rice Yield, %			Hardness	
	Variety	Unstressed	Stressed	Hampas	3-Pt Bending	Kiya breaking
1	PSB Rc50	42	13	30	2.14	7.8
2	PSB Rc72H	49	23	36	2.33	8.5
3	PSB Rc14	50	38	40	1.81	8.9
4	PSB Rc54	55	45	33	2.31	8.6
5	PSB Rc30	56	47	35	2.45	9.3
6	PSB Rc36	56	49	39	2.19	10.7
7	PSB Rc38	56	51	40	2.12	9.5
8	PSB Rc62	57	45	44	1.97	8.9
9	IR42	58	33	45	1.71	8.2
10	PSB Rc52	59	53	34	2.17	8.2

Head rice yield vs variety

	Unstressed	Stressed	Hampas	Environment
IR 42	58 A	33 C	45 A	Irrig lowland
PSB Rc30	56 A	47 A/B	35 B/C/D	Irrig lowland
PSB Rc52	59 A	53 A/B	34 C/D	Irrig lowland
PSB Rc54	55 A	45 B	33 C/D	Irrig lowland
PSB Rc72H	49 B	23 D	36 B/C/D	Irrig lowland, hybrid
PSB Rc14	50 B	33 C	40 A/B/C	Rainfed lowland
PSB Rc36	56 A	49 A/B	39 A/B/C	Rainfed lowland
PSB Rc38	56 A	51 A/B	40 A/B/C	Rainfed lowland
PSB Rc62	57 A	45 B	44 A/B/C	Rainfed lowland
PSB Rc 50	42 C	13 E	30 D	Saline prone

Head rice yield vs variety

- Head rice yield is a weak function of the type of environment rice is being grown
- Juliano & Perez (1993) noted that susceptible variety IR 42 has a critical moisture content (CMC) of 16% , whereas resistant variety IR 60 had a CMC of 14%

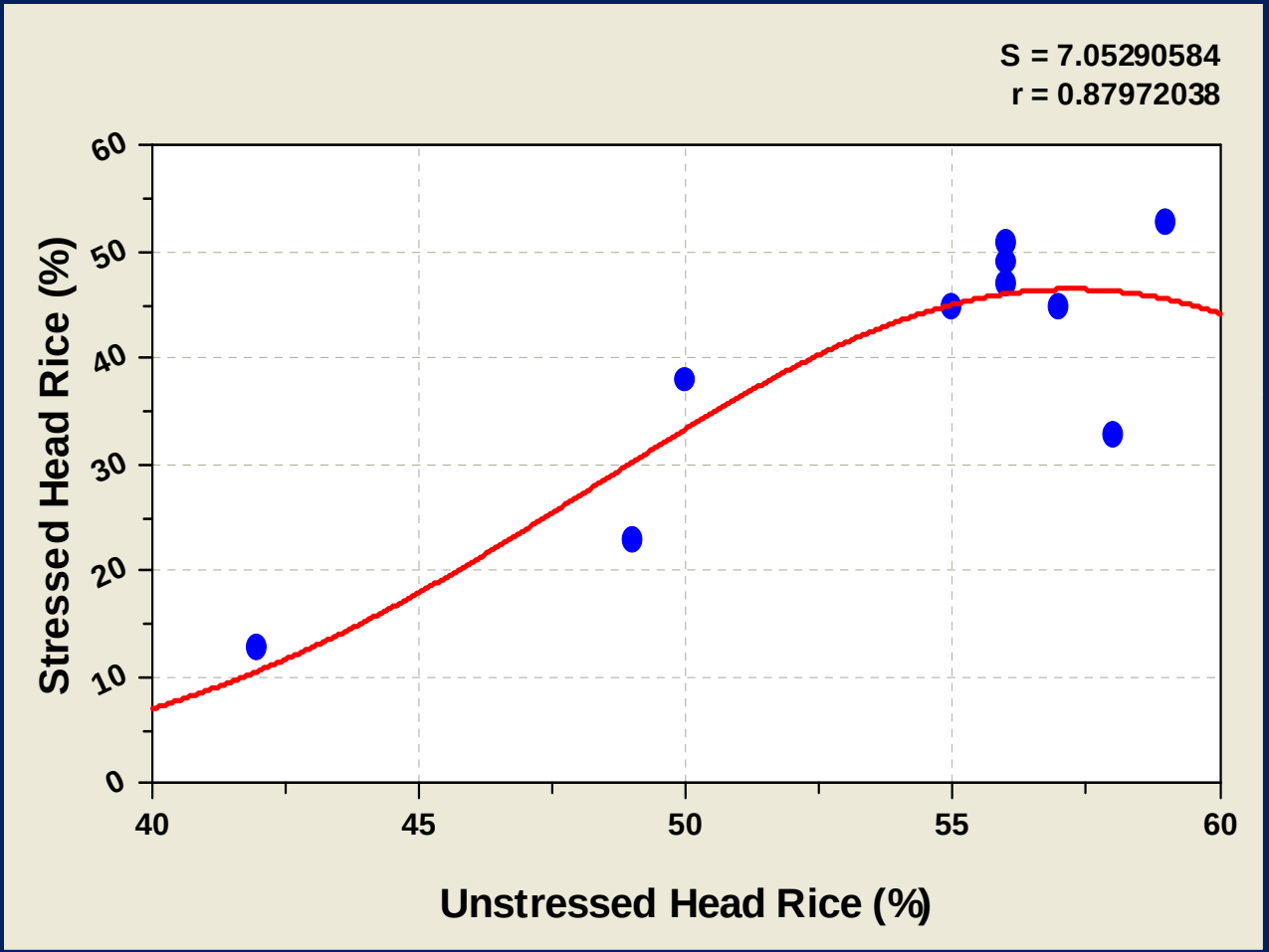
Hardness index vs variety

Variety	Environment	Grain Shape	3pt Bending Hardness, kg	Kiya Breaking Hardness, kg/cm2
IR 42	Irrig lowland	L/S	1.71	8.2
PSB Rc30	Irrig lowland	L/S	2.45	9.3
PSB Rc72H	Irrig lowland	L	2.33	8.5
PSB Rc14	Rainfed lowland	L/S	1.81	8.9
PSB Rc36	Rainfed lowland	M/I	2.19	10.7
PSB Rc38	Rainfed lowland	M/I	2.12	9.5
PSB Rc52	Irrig lowland	M/I	2.17	8.2
PSB Rc54	Irrig lowland	M	2.31	8.6
PSB Rc62	Rainfed lowland	M	1.97	8.9

Hardness index vs variety

- Correlations of breaking hardness with varieties and HRY were generally low or insignificant
- As Lu & Seibenmorgen (1995) noted, compression tests cannot accurately reflect the actual HRY. They also noted that the HRY is highly correlated to paddy average breaking force but not for brown rice and milled rice

Unstressed vs stressed



Gaussian model : SHRY = A * exp ((-B-UHRY)^2)

Conclusion

- The study, using Philippine rice varieties, verified some of the results of other researchers
- There was insignificant correlation between HRY and the Kiya breaking force
- The breaking force is not significantly correlated with head rice yield for brown rice

Conclusion

- Stressed head rice yield method can be used as an alternative to unstressed head rice yield. Variability of results should be further explored.
- Hampas method is not significantly correlated with unstressed head rice yield

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