Research Article

Grain Quality Aspect Indicates Hybrid Rice Development Concern to Indigenous Inbred Varieties

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Abstract | Milling, physical and cooking quality of candidate hybrid varieties of fine and coarse rice category, were tested for their performance against the respective standards. In hybrid category, 58% candidates milling quality found excellent or good (head rice yield– HRY 51-70%), 23% marginal (HRY 40 – 50%) and 18% below limit (< 40%). Physically, 60% samples were extra-long size, slender shape and coarse type. Nineteen percent samples were long or medium size but slender shape and coarse type as well. Whereas, 21% sample were short or medium size only. Regarding cooking quality, 60% samples were excellent or good and 30% were OK (poor quality). The cooking quality of 10% sample was very poor. Overall 50% candidate varieties were excellent or good and 16% were OK whereas only 23% were below standard limit. In fine category, milling quality of only 6% candidates was excellent or good. Both fine and coarse candidates showed 13% and 7%poor milling, while 80% and 69% were under limit respectively. Physically, 19% candidates' from fine category were long size (length 6.1-7.0 mm), considered good and 63% OK. However, 19% candidates were medium size (length 5.0-6.0 mm) below the respective standard (≥ 6.1 mm). Cooking quality of fine category was OK. Overall grain quality of 6% samples graded excellent, 19% well or OK and 56% candidates were below standard. Physically, 7% candidates from coarse category were extra-long size, ranked well and 43% OK while15% was below the standard. Cooking quality of coarse candidates was OK however overall, 21% samples showed poor milling, and physical and cooking quality and 36% did not meet the standard. Ratio of hybrid, fine and coarse candidates obtained for onward protocol was 43%, 24% and 0% respectively. The overwhelming of hybrid candidates with good quality indicates that they have common source, origin and or different brands of the same company.

Received | 20 November, 2016; **Accepted** | 19 April, 2017; **Published** | June 25, 2017
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Citation | Rauf, A., K. Ahad and A.U. Shah. 2017. Response of Wheat to tillage and sowing techniques under arid condition. *Pakistan Journal of Agricultural Research,* 30(2): 162-172.
DOI | http://dx.doi.org/10.17582/journal.pjar/2017/30.2.162.172
Keywords | Hybrid, Inbred rice, Indigenous, Grain quality testing

Introduction

Rice in Pakistan is a monsoon crop but the introduction of hybrid varieties in recent years has influenced the dates for sowing and transplanting of rice. Cultivation of rice by virtue of river Indus basin made Pakistan historically famous for producing and exporting relatively high quality indigenous rice Basmati, Giraud (2013). Besides basmati, coarse grain or IRRI type rice and Japonica or short grain type quality rice also existed side by side (Figure 1). Masood et al. (2013); Siddiqui et al. (2007a; 2007b; 2010) has reported pronounced differences in quality characteristics and diversity from many aspects in the

indigenous germplasm. Since time immemorial, Punjab province is producing more than 90% of the country basmati rice, Ashraf (2001). Overall, 92% of rice covered area concentrates in the two different packets of Punjab and Sind provinces. Out of 92%, 61% concentrates on the indigenous germplasm of Basmati and extra-long grain varieties mainly in Punjab while 31% (Sind province) cultivates long grain exotic germplasm IRRI origin and mostly Chinese originated hybrid rice varieties. Further, categorical cultivation of varieties has been exclusive and in patches throughout the country and production development has been both horizontal and vertical as well. Area and yield or contribution of both together has been significant in the annual production of rice in one or more perspectives irrespective of rice category. Putting aside high fluctuations during the early years of new millennium, production still grew by 2.9% due to % contribution of area and yield 1.7, 1.2 respectively. However, during 1990s and onwards 2000s yield became stagnant and one of the lowest in the world in the range 1-2% change (3200-3500 Kg/acre) due to lack of meaningful technologies, Rauf and Majid (2015); Pervez (2007); Khursheed et al. (1993).

Figure 1: *Some indigenous rice varieties from right to left 'Fine Quality Basmati, coarse IRRI type and hybrid'*

Besides this, trade share of Pakistan's Basmati rice has declined from 40% to less than 20% in the past 15 years instead of expansion in the global trade of Basmati grown from 1 to more than 4 million tons captured alone by India, Mohanty (2012). Average price per unit metric ton (MT) of Pakistan basmati has also decreased over a decade of years by more than 25% which speculates no longer guarantee to premium price due to unique quality of basmati, Rauf et al. (2013). On the other hand, China increased its national average yield 3500Kg/acre - 6200Kg/acre within a short span of 5-6 years by promoting hybrid rice. Considering the possibilities of 2-3 times increase in production through high yielding varieties (HYV), government introduced hybrid rice some years before and allowed private sector to freely import HYV seed to counter yield gap and enhance rice farmers income. In this perspective, ministry for National Food Security and Agricultural Research under the umbrella of PARC-Islamabad, also initiated two mega projects namely IHSPT (Indigenous Hybrid Seed Development) and Pak-China Agricultural Research Collaboration, indulging private sector as well. Introduction of hybrid varieties GNY 50 and GNY 53 through Sind province in 2008-09 is by virtue of private company Guard® Rice Lahore, Khushik et al, (2011). However tremendous pouring of hybrid varieties during 2012-16 seems surprising. According to government Federal Seed department, 105 hybrid varieties have been approved so far and still a large number is to be listed. During 2016, fourteen hybrids of 12 companies have been recommended by the varietal evaluation committee. Others are in the process of adaptability trials. On average nine HYV are approved yearly for commercial cultivation. Further, 6000 MT seed of 60–70 hybrid rice varieties has been imported to replace the open pollinated rice cultivation on more than 0.25 million hectares. Independent of category or source, a candidate rice variety goes through national uniform rice yield trial (NURYT) before its final approval for commercial cultivation. NURYT is the only worldwide standard operating procedure (SOP) for adaptability trails including the grain quality testing as the decisive step in finalizing the recommendation. Following NURYTSOP for grain quality, seventy hybrid rice candidates' varieties, fifteen basmati and nine coarse rice candidates produced during crop season 2014 through national uniform rice yield trial was tested. Quality testing with respect to their respective check variety leaded recommendation of the candidates varieties in the respective category and way forward for HYV seed import measures and control.

Material and Methods

All of the seventy hybrid candidates including the check hailed to private companies. According to policy matter, each company is allowed one or maximum three candidates in the NURYT adaptability trials for two consecutive crop seasons. The candidates of inbred rice both fine and coarse category mostly hails to public sectors. Agronomic adaptability trail is

conducted at pre specified 9-12 locations throughout the country in the four zones of rice ecology. Usually, crop produced on the rice experimental plot using the RCBD (Randomized Complete Block Design) following good agricultural practices (GAP) at National Agricultural Research Centre (NARC) - Islamabad, is taken for grain quality testing.

Samples preparation

Produce was manually harvested and threshed to get rough rice one Kg. Samples were brought to Grain Quality Testing Lab- NARC, and stored for processing to get white rice.

Instrumentation

Electrical paddy cleaner Testing Winnower PS, OHYA TANZO Engineers, Co. Ltd, digital grain moisture tester PB 1D2 Kett®, grain shape tester PEACOCK Dial Gauges (0.10–20 mm & 0.01–10 mm), Triple beam physical balance Ohaus® Inc, Standard mills for husking and polishing rice McGill laboratory mill #1, 2 SATAKE®, Testing rice grader TRG05 SATAKE® Co, Pvt. Ltd; distilled water was used during cooking of rice.

Samples processing

Rough rice was cleaned and graded to top quality paddy through electrical paddy cleaner in the milling lab. Tempering was carried out in lab oven at 40 ^{0}C till moisture contents came to ≤ 12%. Standard mills of 'SATAKE® was used to process each sample 300g to get the milled rice by Champagne et al. (1999) method. Broken rice fraction was separated by grading milled rice usingTRG05 SATAKE® grader (Rauf et al., 2013).

Physical and cooking parameters determination

Quality testing parameters including the milling parameters head rice recovery (HR%), broken fraction (%), husk (%), bran (%); physical characteristics kernel length (mm), breadth (mm), thickness (mm), shape (length breadth ratio LBR), color, appearance, quality index; cooking characteristics cooked kernel length (mm), elongation ration (ratio of post cooked kernel length to pre-cooked kernel length), cooking time, bursting %, stickiness(%), water uptake were determined for each lot basmati, coarse and hybrid category separately. Generally, a good quality rice should have a high percentage of whole unbroken grains, little or no chalk, translucent appearance, uniform coloration and good for the purpose for which it has been produced (white for raw-milled rice and with a yellowish tinge for parboiled rice), shape (length and length-width ratio) should be right for the variety type, excellent cooking properties - should satisfy the consumers' preference for cooked rice for the particular kind of food preparation (Anonymous, 2014). Keeping in view these points, moisture was determined using Kett® moisture testing meter PB ID2 after calibration through moisture testing standard plate PB ID2 Tester 15±0.1 accompanied with the instrument. Length (l), breadth (b), thickness (t), length breadth ratio-lbr(shape), and type– quality index (lbr/t) average for randomly selected 1000 or more grains of replicate was measured on the office table glass of known length (cm) by placing kernels in end to end or side to side arrangement for length and width respectively. Steel scale 30cm long was used to measure width of the kernels placed in queue on the office table glass. Grain shape tester was used to determine the kernel thickness (Dela-Cruz and Khush, 2000). Cooking of the sample hailing to different rice category was carried out as described by Bhonsle and Krishnan (2010); Yadav et al. (2007); Khatoon and Prakash, (2006).

Data analysis

Mean ($\bar{X}$), standard deviation (STD), coefficient of variability (STD/$\bar{X}$X100) of three replicates samples was calculated for milling recovery, kernel physical dimensions including cooked grain length (CGL) following basic statistics.

Results and Discussion

Six samples RH552-RH554, RH559, and RH562-563 showed excellent milling quality head rice (HR% ≥ 66). Twelve samples RH 534, RH536, RH539-RH540, RH547, RH557-RH558, RH561, RH 564-RH566, and RH 570 showed good milling quality (HR% = 56 - 65). Sixteen samples RH503, RH506-RH508, RH511, RH513, RH515- RH516, RH530- RH531, RH535, RH544-RH545, RH548, RH551, and RH556 has milling quality O.K. (HR% = 50-55). Twenty three samples RH501-RH502, RH504-RH505, RH509-RH510, RH514, RH519-RH520, RH525-RH528, RH537-RH538, RH541-RH 543, RH546, RH549-RH550, RH567, and RH569 has poor milling quality (HR% = 40-49). Thirteen samples RH512, RH517-RH518, RH521-RH524, RH529, RH532-RH533, RH555, RH560, and RH568 milling quality was only fair and recommended rejected (HR % < 40).

Regarding physical characteristics, only sample RH531 has excellent characteristic. Eighteen samples RH503-RH506, RH511, RH515-RH516, RH521, RH526, RH530, RH532, RH536, RH538, RH541-RH542, RH551, RH561 and RH568 has good size, shape and grain type Fine. Twenty three samples RH501-RH502, RH510, RH512-RH514, RH519-RH520, RH528, RH544, RH547-RH548, RH552-RH553, RH555, RH557, RH559, RH562, RH564-RH565, RH567 and RH569-RH570 are physically O.K. in size and shape. However, thirteen samples RH507-508, RH517-18, RH527, RH529, RH534-RH535, RH540, RH543, RH545, RH550 and RH556 are poor due to medium size but shape slender while fifteen samples RH509, RH518, RH522-RH525, RH533, RH537, RH539, RH546, RH546, RH558, RH560, RH563 and RH566 has either short or medium size only and recommended rejected in this respect.

Cooking quality of fourteen samples RH501, RH505-RH506, RH513-RH514, RH517-RH518, RH522, RH528, RH541, RH543, RH549, RH555 and RH570 is excellent due to good cooked kernel length, elongation ratio, zero bursting and well separated cooked kernels. Thirteen samples RH511, RH515, RH519-RH520, RH524, RH527, RH529-RH530, RH540, RH542, RH554, RH556 and RH562 are good in cooking. Thirty three samples RH502-RH504, RH507, RH510, RH512, RH516, RH521, RH523, RH525-RH526, RH531-RH532, RH534-RH536, RH538-RH539, RH545-RH548, RH550, RH552, RH560, RH563-RH564 and RH567-RH569 are O.K. in cooking quality. However, seven samples RH537, RH544, RH551, RH553, RH558, RH561 and RH565 have poor cooking quality and only three samples RH533, RH557 and RH559 are recommended rejected due to fair cooking quality as contact kernels.

Overall grain quality testing of the samples RH506, RH513- RH515, RH528, RH530, RH536, RH541, RH543, RH522, RH559, RH561-RH562 and RH570 have been found good. The overall quality of the samples RH501, RH503-RH505, RH507-RH508, RH511, RH517, RH519, RH526-RH527, RH531, RH535, RH538-RH540, RH542, RH545, RH547-RH548, RH551, RH553-RH554, RH556-RH557, and RH563-RH566 is also O.K. But samples RH502, RH509-RH510, RH519, RH534, RH544, RH549-RH550, RH558, RH567 and RH569 have poor quality and need reconsideration. Sixteen samples including RH512, RH517-RH518, RH521-RH525, RH529, RH532-RH533, RH537, RH546, RH555, RH560 and RH568 are only fair in quality as shown in annex-1 and are not recommended for consideration in varietal evaluation committee (VEC). Results of milling, physical and cooking quality tests of the hybrid candidates varieties are summarized in Table 1.

Fine and Coarse group both rough rice samples quality was poor and under threshed, therefore samples were repeatedly cleaned on Electrical paddy cleaner Testing Winnower PS, OHYA TANZO Engineers, Co. Ltd, and were graded to get seed quality paddy sample before milling in three replicates each weight 80-300g. Moisture contents of samples were also beyond range of the moisture testing instrument Kett(R) PB ID2 (maximum measurable limit 20%). Therefore, samples were tampered till moisture contents ≤ 12%.

In the fine group, out of total sixteen samples FR1-FR13, Super basmati, EFI-30-39-04 and EFI-20-52-04 tested, only FR-7 and Super basmati are excellent in milling quality (head rice ≥ 66%) while sample FR-1 is also good in milling quality (head rice % = 61). However, only two samples FR13 and EFI-20-52-40 are poor in head rice % recovery (HR%= 40-49). All remaining FR02- FR06, FR08-FR12 and EFI-30-39-04 fail due to milling quality (HR% < 40). Physically, samples FR04-FR05 and FR07 have extra-long size (l > 7.5mm) and good. Samples FR01, FR03, FR06, FR08-09, FR12-FR13, Super basmati, EFI-30-39-04 and EFI -20-52-04 are also O.K. in size, shape and grain type. However, three samples FR02, FR10-FR11 are poor in physical quality due to medium size. Regarding cooking quality of all samples is O.K. (L/l = > 1.5). However, overall quality of the NURYTs of this Fine group samples can be reported as excellent for sample FR07, Super basmati as control. Samples FR01, RF13 and EFI -20-52-04 are also good or O.K. in quality. But samples FR02, FR06, FR08-FR12 and EFI-30-39-04 were poor in quality (Table 2).

In the Coarse group, CR01-FR09 including IR- 6 as standard, samples have very low head rice recovery (HR% < 40%) and are fail, except sample CR03 and CR05-CR06 have head rice recovery (HR% 40-49) but still poor. Regarding physical characteristics, sample CR08 kernel has extra-long size and is considered

Table 1: *Grain quality characteristics of few indigenous rice varieties.*

Variety Name	1000 GW	PGL	PGB	MGL	MGB	LBR	Size	Shape	Protein (%)	AC%	ASV	GC	Aroma
Basmati370	21.0	9.50	2.20	6.70	1.60	4.19	Long	Slender	8.30	20.00	5.3	53	Strong
Jhona-349	-	9.09	2.33	6.36	2.00	2.86	Medium	Intermediate	10.00	28.00	RDNA		Nil
Mushkan7	-	9.50	2.10	6.70	1.92	3.50	Slender	Sword	9.00	24.00			Strong
Sathra-278	-	9.54	2.30	6.70	2.20	2.81	Medium	Bold	7.40	26.00			-
Palman-sufaid	-	9.90	2.00	6.90	1.70	4.05	Long	Slender/Fine	7.60	27.80			-
Bas C-622	22.0	9.40	2.10	6.90	1.70		Long	Slender	7.90	24.00			Strong
Bas-6129	22.5	10.90	2.20	7.70	1.80	4.27	Extra-long	Slender	8.70	20.84	5.9	54	Moderate
IR-8 (IRRI-Pak)	-	8.81	2.65	6.40	2.60	2.29	Medium	Bold	7.10	28.66	7.0	35	Nil
Bas-198	23.0	9.70	2.26	6.90	1.90	3.63	Long	Slender	7.30	20.69	6.8	55	Moderate
PK-177	21.9	9.80	2.30	6.90	1.60	4.31	Long	Slender	10.10	22.20			Moderate
KS-282	25.5	9.80	2.30	6.70	2.00	3.35	Long	Slender	8.30	28.05	7.0	47	Nil
Basi-385	22.0	9.60	2.20	6.80	1.60	4.25	Long	Slender	8.60	23.18	6.1	58	Moderate
Super basm	22.5	11.20	2.11	7.40	1.60	4.63	Extra-long	Slender	8.90	24.80	4,7		Strong
Bas-2000	23.0	10.89	1.97	7.68	1.83	4.19	Extra-long	Slender	8.10	25.20			Strong
KashmiBas	20.0	9.80	2.30	6.61	1.80	3.67	Long	Slender	6.50	20.15	5.0	60	Strong
NIAB-IR9	24.0	10.50	2.40	6.67	1.60	4.38	Long	Slender	7.23	22.29	RDNA		Nil
ShainBasmati	20.5	9.88	2.00	7.23	1.77	4.08	Extra-long	Slender	7.00	22.96			Moderate
Rachna Basmati	23.0	9.90	2.20	6.85	1.79	3.84	Long	Slender	8.00	24.90			Moderate
IR-6 (Mehran-69)	25.0	9.70	2.40	6.62	1.90	3.65	Long	Slender	7.90	29.69	7.0	58	Nil
Jajai-77	19.9	9.42	2.73	6.55	1.34	4.10	Long	Slender		17.60			Strong
Kangni-27	24.1	10.10	2.51	6.43	2.08	3.20	Long	Slender		26.63			Nil
DR-82	23.5	9.45	2.19	6.40	1.60	4.00	Long	Slender	8.50	28.18	5.1	82	Nil
DR-83	22.5	9.68	2.27	6.82	1.88	3.62	Long	Slender	8.60	21.62	4.6	61	Nil
Lateefy	21.2	9.20	1.90	6.40	1.60	4.00	Long	Slender	8.60	27.70	7.0	58	Mod/Strong
Sada Hayat	24.7	9.34	2.32	6.59	2.00	3.29	Long	Slender	7.80	27.70	RDNA		Nil
DR-92	25.9	8.78	2.27	6.83	2.15	3.18	Long	Slender	9.30	30.50			Nil
Shua-92	24.5	9.54	2.13	7.00	2.05	3.46	Long	Slender	7.76	30.70			Nil
Khushboo-95	25.0	9.20	2.26	6.41	1.98	3.24	Medium	Slender		29.80			Moderate
Shadab	24.0	10.19	2.39	7.52	1.84	4.08	Extra-long	Slender	8.58	30.07			Nil
Sarshar	29.0	9.64	2.57	7.11	2.16	3.29	Long	Slender		28.00			Nil
JP-5	24.2	7.80	4.20	5.80	3.00	1.90	Medium	Bold	6.40	22.70	6.0	67	Nil
Swat-1	24.5	9.40	3.20	6.71	2.32	3.89	Long	Medium	10.20	17.80	RDNA		Nil
Swat-2	26.0	9.50	3.20	6.55	2.38	2.75	Long	Medium	10.50	18.00			Nil
Pakhal	22.9	10.00	2.21	6.60	1.90	3.47	Long	Slender	8.00	24.70			Nil
Mahlar-346	-	9.40	2.56	6.55	2.08	3.14	Medium	Slender	6.90	27.00			-
IR-841 (Abba-si-72)	24.2	9.32	2.20	6.62	1.92	3.48	Long	Slender		24.05			Nil
Dokri Basmati	22.7	11.20	2.11	6.89	1.77	4.43	Long	Slender		21.73			Strong
Kangni x Torh	20.6	9.23	2.40	6.64	2.17		Long	Slender		24.32			Nil
Sugdasi (Bengalo)	22.9	10.17	2.28	6.38	1.91	4.10	Long	Slender		19.70			Strong

MG: *milled grain;* **PG:** *paddy grain;* **CGL:** *cooked grain length;* **LBR:** *length breadth ratio;* **GW:** *grain weight;* **ASV:** *Alkali spread value;* **AC:** *Amylose contents;* **GC:** *Gel consistency;* **GT:** *Gelatinization temperature;* **RDNA** *stands for reliable data not found;* **Source:** *Dr. Muhammad Ashiq Rabbani- Principal Scientific officer- NARC, Islamabad*

Table 2: *Hybrid rice candidates varieties milling, physical, cooking quality results.*

Hybrid code	*Milling Quality		**Physical Quality(size/shape)		***Cooking Quality		Final Remarks
	%HR	Grade	Description	Grade	Description	Grade	
RH 501	40	Poor	Size Long	O.K.	14/7.4= 1.89	Excellent	O.K.
RH 502	40	Poor	Long only	O.K.	10/6.99= 1.4	O.K.	Poor
RH 503	51	O.K.	Long, slender	Good	10.5/7.28= 1.44	O.K.	O.K.
RH 504	43	Poor	Long, slender	Good	10.5/7.05 = 1.49	O.K.	O.K.
RH 505	41	Poor	Long, slender	Good	11.4/ 6.78= 1.68	Excellent	O.K.
RH 506	50	O.K.	Long, slender	Good	11.5/6.78 = 1.7	Excellent	Good
RH 507	50	O.K.	Medium, slender	Poor	10.4/ 6.53= 1.59	O.K.	O.K.
RH 508	50	O.K.	Medium, slender	Poor	10/ 6.26 = 1.59	O.K.	O.K.
RH 509	45	O.K.	Medium size	Rejected	9.8 / 6.44 = 1.52	O.K.	Poor
RH 510	50	Poor	Long only	O.K.	10.8/ 6.68= 1.62	O.K.	Poor
RH 511	50	O.K.	Long, slender	Good	11.4/ 7.28= 1.57	Good	O.K.
RH 512	37	Fail	Long only	O.K.	10.1/7.0 = 1.44	O.K.	Fail
RH 513	55	O.K.	Long only	O.K.	11.3/6.79 = 1.66	Excellent	Good
RH 514	42	Poor	Long only	O.K.	11.8 6.79 = 1.74	Excellent	Good
RH 515	50	O.K.	Long, slender	Good	11.6/7.34 = 1.58	Good	Good
RH 516	54	O.K.	Long, slender	Good	10/ 6.83 = 1.46	O.K.	O.K.
RH 517	32	Fail	Medium, slender	Poor	12.5/ 6.57= 1.9	Excellent	Fail
RH 518	31.2	Fail	Medium size only	Rejected	11.8/ 6.58 = 1.8	Excellent	Fail
RH 519	40	Poor	Long size only	O.K.	11.6/ .05 = 1.65	Good	Poor
RH 520	45.5	Poor	Long size only	O.K.	11.5/ 7.08 = 1.6	Good	O.K.
RH 521	21	Fail	Long, slender	Good	10.7/ 7.3 = 1.5	O.K.	Fail
RH 522	30	Fail	Medium size only	Rejected	11.5/ 6.3 = 1.8	Excellent	Fail
RH 523	33	Fail	Medium size only	Rejected	9.4/ 6.3 = 1.5	O.K.	Fail
RH 524	37	Fail	Medium size only	Rejected	10/ 5.9 = 1.7	Good	Fail
RH 525	40	Poor	Medium size only	Rejected	9.8 / 6.5 = 1.51	O.K.	Fail
RH 526	47	Poor	Long, slender	Good	10.8 / 6.78 = 1.6	O.K.	O.K.
RH 527	41	Poor	Medium , Slender	Poor	10.9 6.49 = 1.68	Good	O.K.
RH 528	48	Poor	Long size only	O.K.	11.3/ 6.83= 1.65	Excellent	Good
RH 529	23	Fail	Medium, Slender	Poor.	10.0/ 6.23= 1.61	Good	Fail
RH 530	52	O.K.	Long, slender	Good	11.5/6.99 =1.65	Good	Good
RH 531	50.2	O.K.	Extra-long, slender	excellent	11/ 7.72 = 1.5	O.K.	O.K.
RH 532	35	Fail	Long, slender	Good	9.8 / 6.83 = 1.43	O.K.	Fail
RH 533	22	Fail Rejected			rejected	rejected	Fail
RH 534	59	Good	Medium , slender	Poor	9.9 /6.26 = 1.58	O.K.	Poor
RH 535	54	O.K.	Medium , slender	Poor	10/ 6.4 = 1.6	O.K.	O.K.
RH 536	60	Good	Long , Slender	Good	11/ 6.83 = 1.6	O.K.	Good
RH 537	49	Poor	Medium size only	Rejected	9.11 / 6.3 = 1.45	Poor	Fail
RH 538	43	Poor	Long, slender	Good	10.2/6.94 = 1.5	O.K.	O.K.
RH 539	59	Good	Fair	Rejected	9.8 / 6.3 = 1.56	O.K.	O.K.
RH 540	63	Good	Medium, slender	Poor	10.6 / 6.6 = 1.61	good	O.K.
RH 541	43	Poor	Long, slender	Good	12.2 / 6.7 = 1.82	Excellent	Good
RH 542	49	Poor	Long, slender	Good	11.0 /6.7 = 1.69	Good	O.K.
RH 543	43	Poor	Medium Slender	Poor	11.0 6.35 = 1.73	Excellent	Good

RH 544	50	O.K.	Long size only	O.K.	8.7 / 6.83 = 1.3	Poor	Poor
RH 545	52	O.K.	Medium , Slender	Poor	9.9 / 6.49 = 1.53	O.K.	O.K.
RH 546	48	Poor	Medium size only	Rejected	10.2 /6.63 1.54	O.K.	rejected
RH 547	61	Good	Long, slender	O.K.	9.7/6.8 = 1.43	O.K.	O.K.
RH 548	52	O.K.	Long size only	O.K.	10.5/ 6.6 = 1.6	O.K.	O.K.
RH 549	45	Poor	Medium, slender	Poor	11.0 / 6.1= 1.78	Excellent	Poor
RH 550	47	Poor	Medium, slender	Poor	10.4/ 6.31= 1.65	O.K.	Poor
RH 551	53	O.K.	Long slender, Fine	Good	10/ 7.2 = 1.39	Poor	O.K.
RH 552	68	excellent	Long and slender	O.K.	10.7 / 7 = 1.53	O.K.	Good
RH 553	67	excellent	Long and slender	O.K.	8.8 / 6.63 = 1.33	Poor	O.K.
RH 554	66	excellent	Medium size only	Rejected	10.7 / 6.3 = 1.7	Good	O.K.
RH 555	36	Fail	Long and slender	O.K.	12.4 /6.7 = 1.85	Excellent	Fail
RH 556	57	O.K.	Medium , slender	Poor	10.8 / 6.4 = 1.7	Good	O.K.
RH 557	64	Good	Long, slender	O.K.	8.9 / 6.8 = 1.31	Rejected	O.K.
RH 558	57	Good	Medium size only	Rejected	9.2 / 6.3 = 1.51	Poor	Poor
RH 559	66	excellent	Long, slender	O.K.	10.8 / 6.7 = 1.2	Rejected	Good
RH 560	36	Fail	Medium size only	Rejected	10.3/ 6.6 = 1.56	O.K.	Fail
RH 561	64.4	Good	Extra-long size	Good	10.9 /.04 = 1.13	Poor	Good
RH 562	67	excellent	Long size only	O.K.	11.2 6.73 = 1.66	Good	Good
RH 563	67	excellent	Medium size only	Rejected	10.4 / 6.3 = 1.65	O.K.	O.K.
RH 564	61	Good	Long, slender	O.K.	10.7 / 6.7 = 1.6	O.K.	O.K.
RH 565	61	Good	Long, slender	O.K.	9.0 / 6.73 = 1.33	Poor	O.K.
RH 566	58	Good	Medium size only	Rejected	9.2 / 6.5 = 1.42	O.K.	O.K.
RH 567	45	Poor	Long, slender	O.K.	10 / 6.63 = 1.51	O.K.	Poor
RH 568	16.4	Fail	Long slender, Fine	Good	10.4 / 7.4 = 1.41	O.K.	Fail
RH 569	43	Poor	Long, slender	O.K.	10.5 /.94 = 1.51	O.K.	Poor
RH 570	61	Good	Size Long only	O.K.	12.1 /.94 = 1.74	Excellent	Good

**Milling quality is evaluated on the basis of head rice (HR) % yield; Excellent = ≥66%; Good = 56-66%; O.K = 50-55%; Poor 40-49%; and below 40 = fail (shall be rejected); **Physical quality is evaluated on the basis of size (length) of the kernel. Minimum required for hybrid kernel is 6.7mm. l= ≥ 7.6 mm (Excellent); l= 7.1-7.5mm (Good); l= 6.6-7.0mm (O.K.); l= 6.0-6.5mm (Poor) and l = < 6.0 (Fair- rejected). ***Cooking quality is evaluated on the basis of Cooked Grain Length (CGL), bursting %, Kernel elongation ratio, kernel stickiness, cooking time, water uptake etc. RH = Hybrid rice*

good. Similarly, CR02-CR03, CR05-CR07 and CR09 are also O.K. regarding size and shape. However, sample CR01 and CR04 have poor physical quality due to medium size. Cooking quality of all the samples of this group is O.K. However, overall quality evaluation is O.K. to some extent for CR03 and CR05-06. But samples CR01-02, CR04, CR08-09 are poor in quality (Table 2).

Candidates' varieties participatory fractions 69, 15, 9, excluding the respective check, hail to Hybrid, Fine quality rice basmati and the IRRI type or coarse respectively, indicated HYV challenge to high quality indigenous inbred basmati and the coarse varieties (Tables 2 and 3). Accordingly, the successful candidates' percent fraction hailing to Hybrid, Fine and Coarse category for varietal evaluation committee (VEC) consideration was 43%, 24% and 0%, respectively. Overwhelming percent of hybrid varieties with the equally good quality characteristics implicate most candidates in the same category have common source or origin and seems different brands of the same company. Most probably, this is due to government will to promote private sector in agricultural research through seminar and meetings contrary to lack of investment in the public and private sectors to encourage and promote indigenous rice varietal development on regular basis. Hybrid rice

Table 3: *Fine group, coarse group candidates rice varieties milling, physical, cooking quality tests results*

Inbred Variety code	*Milling Quality		**Physical Quality(Size/Shape)		***Cooking Quality		Final Remarks
	%HR	Grade	Description	Grade	Description (L/l)	Grade	
FR-1	61	Good	Long slender Fine	O.K.	11.2/6.99= 1.6	O.K.	O.K.
FR-2	32	Fail	Medium slender Fine	Poor	9.9 / 6.5 =1.52	O.K.	Poor
FR-3	37	Fail	Long slender Fine	O.K.	13.2 /7.1= 1.9	O.K.	Poor
FR-4	24	Fail	Extra-long slender Fine	Good	12.6 / 7.78=162	O.K.	Poor
FR-5	23	Fail	Extra-long slender Fine	Good	12.5 / 7.6= 1.65	O.K.	Poor
FR-6	34	Fail	Long slender Fine	O.K.	10.5 /7.23=1.5	O.K.	Poor
FR-7	66	Excellent	Extra-long slender Fine	Good	11.9 / 7.9=1.5	O.K.	Good
FR-8	15	Fail	Long slender Fine	O.K.	12.2/ 7.3=1.67	O.K.	Poor
FR-9	27	Fail	Long slender Fine	O.K.	11/ 7.1= 1.55	O.K.	Poor
FR-10	31	Fail	Medium slender Fine	Poor	9 /6.2 = 1.45	O.K.	Poor
FR-11	21	Fail	Medium slender Fine	Poor	11.3 / 6.5= 1.74	O.K.	Poor
FR-12	34	Fail	Long slender Fine	O.K.	11.2/7.2 = 1.8	O.K.	Poor
FR-1 3	47	Poor	Long slender Fine	O.K.	12.2/7.2 = 1.7	O.K.	Good
Super basmati	69	Excellent	Long slender Fine	O.K.	12.4/7.16=1.73	O.K.	excellent
EFI3039	34	Fail	Long slender Fine	O.K.	10.9/6.73=1.62	O.K.	Poor
EFI2054	42	Poor	Long slender Fine	O.K.	10.9/6.8=1.6	O.K.	O.K.
Coarse Group Candidates CR01-09 Varieties					**IR- 6 is Standard**	O.K.	**Remarks**
CR-1	18	Fail	Medium coarse	Poor	9.8 /6.35= 1.54		Fail
CR-2	37	Fail	Long slender coarse	O.K.	10.6/6.73= 1.58	O.K.	fail
CR-3	43	Poor	Long slender coarse	O.K.	10.8/6.68 =1.62	O.K.	Poor
CR-4	22	Fail	Medium slender coarse	Poor	9.5/6.5 = 1.46	O.K.	Fail
CR-5	42	Poor	Long slender coarse	O.K.	9.8/ 6.88=1.42	O.K.	Poor
CR-6	42	Poor	Long slender coarse	O.K.	11/ 6.88=1.62	O.K.	Poor
CR-7	29	Fail	Long slender coarse	O.K.	10.7/ 6.88=1.55	O.K.	Fail
CR-8	35	Fail	extra-long slender coarse	Good	11.4/7.5 =1.52	O.K.	Fail
CR-9	33	Fail	Long slender coarse	O.K.	9.8 /6.88 = 1.42	O.K.	Fail
IR-6	55	Good	Long slender coarse	O.K.	12.5/ 6.83=1.83	O.K.	Good

**Milling quality is evaluated on the basis of head rice (HR) % yield; Excellent = ≥66%; Good = 56-66%; O.K = 50-55%; Poor 40-49%; and below 40 = fail (shall be rejected); **Physical quality is evaluated on the basis of size (length) of the kernel. Minimum required for Fine type quality kernel is ≥ 6.61mm. l= ≥ 7.6 mm (Excellent); l= 7.1-7.5mm (Good); l= 6.6-7.0mm (O.K.); l= 6.0-6.5mm (Poor) and l = < 6.0 (Fair-rejected). ***Cooking quality is evaluated on the basis of CGL (L ≥ 13 mm), bursting % (maximum 5%), Kernel elongation ratio (L/l ≥ 1.6), kernel stickiness (3-5), cooking time, water uptake etc. FR and CR mean Fine rice and coarse rice, respectively.*

introduction aimed to increase production 2-3 times seems counter affected by quality resulting loss of public sector interest to serve farmers through indigenous germplasm improvement. Low quality produce would further deteriorate the average price per unit metric ton (MT) as it once happened in Thailand, Rauf et al. (2013). Nutshell will bulk produce for the bulk sale.

Most of the hybrids are China origin and some are Indian brands. For this purpose, sporadic spread of various brands with single origin needs appropriate measures and control. According to estimates, about 5-92 percent seed sown in the country is uncertified (The verdict on hybrid rice in Pakistan; DAWN. COM). The rice hybrids are getting popular in the country and so far 95 rice hybrids belonging to different companies have been recommended by Pakistan Agricultural Research Council (PARC) Variety Evaluation Committee (VEC) for general cultivation mainly in Sind, Baluchistan and Southern Punjab. On average, 5–7 hybrid varieties are annually approved for commercial cultivation besides knowing grain quality particularly hybrid rice cooking is poor compared to indigenous varieties. At present, hybrid rice, becoming increasingly popular among farmers, is being planted on more than 0.25 million acres

Table 4: *Rice export approximate status 2000 – 2015*

Export parameter	Marketing Years (May- July)														
	2001	002	003	004	005	006	007	008	009	2010	011	2012	2013	2014	2015*
	Basmati – Fine quality rice varieties														
Volume million MT	0.73	0.6	0.8	0.82	0.67	0.84	0.9 1	1.138	0.97	0.98	1.13	0.97	0.63	0.26	0.27
					Av = 0 .81 million				Av = 0975						
Worth Million $	482	481	461	419	450	480	560	1068	1071	856	1068	963	883	858	803
		Average = 425.5						Av = 1070				Av: = 877			
USD Price/MT	RDNA					572	613	940	1099	874	826	483	460	1094	1161*
± % Worth growth	+	0	-5	-9	+7	8	+16	+92	0	- 20		-21	-21	-----	+ 2.6
±%Vol. growth		-18	+25				+26		-14	0.51	+16	- 69			+ 3.26
± % in Price/MT	+25					+7	-17	+53	0	-20	-6	+12	-14.1		
Non-basmati varieties			(*stands six months July-December)												
Volume million-MT	1.2	0.6	1.1	0.1	0.21	2.85	2.2	1.67	1.755	3.03	4.564	2.756	2.859	1.44	1.52*
Worth Million $	162	167	178	180	238	700	559.5	767	913	1328	1197	1236	1527	649.6	674.5*
$Price/MT	RDNA	238	256.39	259.11	238	257	290	498	351	372	435.3			451	444*
± % Worth growth	-41.9	+10			+25	+66	+ 9		+ 42		+ 16	-14.1		451	443.5
±%Volume growth	+ 25						+ 22	- 5	+ 72.94			-37			+ 3.84
							+ 59								
±% Price/MT	RDNA		+ 8	+13	+ 79	+ 19	+ 16		+13	-16		-8.0	RDNA		
Total Rice Export Status			(*stands six months July-December)												
volume million MT	1.934	1.387	1.5	1.2	2.7	3.7	3.13	2.81	2.73	3.5	3.1	3.2	3.5	2.71	2.78*
							Average 3.2 Million								
Worth Million $	526	458.82	639	600	+ 1000	1195	1125	1836	1983	2184	2160	1919	2185	945	978*
USD Price/MT	456		179		497	314	359.79	653.60	726.63	542.14	433	404	937	552	549*
± %Worth growth	-33	-30	+13	-5.6		+3	- 8	+63	+ 9.74		-20		+14	548.4	552.2*
±%Vol growth	-20		+25			+15	-10	- 3	-3	+ 47.09	-8		+7.4	-0.2	4.18*
							Average = -14								
±% Price/MT	456		179		+15	-15	+55	+82	+11	-25	-16		-7.4	0.69	-8.44*

RDNA *reliable data not available;* **MT:** *Metric ton (MT =1000Kg);* ***:** *July to December*

across the country. In Baluchistan, it is being planted in districts Jaffarabad, Nasirabad and Usta Muhammad, and in Punjab, it is being cultivated in districts Multan, Sadiqabad, Rahimyar Khan, Dera Ghazi Khan, Bahawalpur and other areas. Hybrid rice seems increasingly replacing the area under non-basmati varieties especially in Sind province, Southern Punjab, Baluchistan and KPK. According to 2008-09 survey report, hybrid seed is vigorously applied in Sind. It is more popular in lower Sind than upper Sind. It covers 40% and 18% area in lower and upper Sind respectively, 23.12% of the total rice area in Sind province. 19% of the total hybrid rice in Sind is occupied by the single company alone Guard Rice® Pakistan Products GNY-50, GNY -53, LP-20 etc, Khushik et al. (2011).

Some years before, farmers' desire has been driving force behind the varietal spread, asking for seed of super quality variety. Now a -days, he is confused by the seed hawkers hovering its farm. Farmers have also changed their mind set to market oriented varieties after the global rice crisis year 2008, FAO (2010). Basmati growers have slowly shifted from the most popular indigenous variety Super basmati to the better quality Indian brands. As a result Punjab public sector has to registered Indian brand Kayaanat by name PS-2. Similarly, extra-long grain Indian varieties 1121 (kernel size 8.45 mm; yield 5000Kg/ha) and super seeder 1129 another representative of Pusa rice category with higher yield 6000Kg/ha and equal size (8.5mm) are promising replacing the indigenous basmati germplasms. Similarly, coarse rice packets of Sind province is replaced by Chinese hybrid rice as evident from the milled rice export status (Table 4). Year 2008–09 has been peak year of export when country earned USD 1.02 million against basmati rice export 924358 tons at the average unit record peak price USD 1102 per ton and value USD 1.03 million from 2.0 million MT of non-basmati export with average unit record peak price USD 511 per ton (Table 3). After that, slow down both in total of worth of rice export and average price value per unit MT particularly of basmati category can be seen in the Table 4. Besides higher yield perspective, there seems a holocaust change from other aspects including the habits of rice buying, cooking and eating in modem recipes and cuisines. Majority consumers are nontraditional street population whose number is far greater than the traditional rice consumers. Cooking quality of non-basmati rice even by traditional ways is at par or better than the Fine quality basmati rice when especial skill is applied. Presently, bulk cooking is more common. Cooking of basmati rice in alkaline phase –addition of enough fresh lemon or dried plum has enough implications imparting spiciness, fluffiness, shining, reduced cooking time, and increased retro gradation. On the other hand, investment on basmati development has been ignored. Varietal development in indigenous basmati is marginal due to its photosensitive ecology Ashraf, (2001). Consumers normally do not score aroma as thought in the past. Differential acidic (sweet) taste of basmati is also meaningless to nontraditional consumers. In addition to this, basmati market is limited mostly to polished grain, traditional and highly competitive. Rice other types products market include par boil rice, brown or cargo rice and extra-long grain etc are mostly non-basmati. Therefore, indigenous basmati rice has to compromise on its declining average price value per unit MT otherwise it could not sustain as food or ingredient in food. Most popular technology Super basmati is degenerating itself due to blight susceptible. If standard for extra-long grain are revised (l ≥ 7.5 mm) then the variety (length =7.49 mm) would lose the scale where Indian brands has size even greater than 8.45 mm with yield 5000Kg/ha as shown in Table 4.

Table 5: *Pakistani, Indian varieties yield and quality comparison*

Variety name	Rough Rice (Paddy) Yield	Head Rice (HR) %	Kernel length (mm)
1121	5000	-----	8.4
1509	6000	-------	8.4
Kayaanat	4500	63	8.2
Pakistani varieties			
Shaheen basmati	4500	62.7	7.23
Basmati 2000	3550	53.0	7.26
Super Basmati	3500	58.8	7.44
Basmati Pak (6129)	2500	60	7.30
PS-2	4500	63	8.2
Kernel Size Standard Classification			
Standard		Kernel Length (mm)	
Extra-long		> 7.5 mm (old > 7.1)	
Long		6.61-7.5	
Medium size		5.51-6.60	
Short		3.0 -5.50	
Rounded/ Bold if length < breadth			

Conclusion

Chinese brands HVY are replacing the indigenous coarse varieties and Indian brands extra-long varieties are replacing the indigenous fine quality basmati varieties. Overwhelming majority of hybrid varieties with

the same good quality characteristics implicate most candidates' varieties have common source, origin and seems different brands of the same company.

Authors Contribution

RA conceived the idea and collected data. KA entered data in SPSS and analyzed it, wrote some parts f the manuscript and provided technical support. AS wrote the manuscript.

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