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The World Market of Fragrant Rice, Main Issues and Perspectives

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Abstract

Worldwide rice production totaled 481 million metric tons in 2011, including 7.1% in trade. Fragrant rice is estimated to account for 15-18% of the rice trade procuring the highest prices on the world market. Some new players are interested in entering this premium segment, including the US, Vietnam, and other rice growers and traders. The fragrant rice commodity chain is deciphered through a meta-analysis of data on rice cropping and trading. We conclude on a possible split between fragrant and coarse rice markets. The upcoming challenges for fragrant rice industry are discussed with the next release of genetically modified varieties; water scarcity in rice cropping; and land use trade-offs between fragrant and coarse rice.

Keywords: fragrant rice, basmati, jasmine, world trade, premium market

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Introduction

Rice is a dietary staple for at least 62.8% of the inhabitants on the planet and accounts for 20% of the caloric intake for the world population. In Asia it accounts for 29.3% (Timmer 2010). This segment varies from 26.8% for China to 69.8% for Bangladesh. Recent increases and drops in agricultural commodity prices affected the rice trade market, but fragrant rice prices did not really decrease after the peak in the spring of 2008 and, it has remained the highest priced sector of the world rice market. Fragrant rice is priced on the world trade market at USD $1,050 per metric ton (T) or more, whereas coarse rice is USD $440-580/T (FAO 2012). Currently, fragrant rice is a niche market for the premium segment, whereas the main market for coarse rice trading is through government procurements related to food policy and security in Asia and Africa.

Fragrant rice is generally identified by three main factors: appearance, aroma and taste (Chaudhary, Tran and Duffy 2003). It is characterized as a superfine grain, with a pleasant and subtle aroma. It has a soft texture and extreme grain elongation with a breadth-wise swelling that occurs with cooking. Basmati and jasmine are premium long grain rice. Their high value comes from the characteristic fragrance in both the raw and cooked states, and for the distinctive shape of the grain, which upon cooking elongates to almost double its length whilst its width remains the same. In addition to having a desirable taste and texture, basmati and jasmine rice are reported to be a good source of slow releasing carbohydrates, i.e. it has a low glycemic index compared with other rice (Singh, Singh and Khush 2000). Basmati rice has traditionally been grown in the north and northwestern part of the Indian sub-continent for centuries. The best cropping conditions for jasmine are found in north and northeastern Thailand. Fragrant rice grows best and produces the best quality grains under warm, humid, and valley-like conditions. Because of the attractive price premiums, some stakeholders are prone to provide fragrant rice, not sourced from its genuine regions and consequently offer consumers less aroma.

This article examines the fragrant rice trade and its business prospects by analyzing recent, original, diverse and scarce data available in 2012. It is sourced from several databases and contrasted with previously published analyses. The research question is: Will fragrant and coarse rice segments have the same future in trade? A meta-analysis of data issued from published reports was conducted and positioned within a comprehensive literature review focused on fragrant rice. This article discusses fragrant rice pricing, trading and cropping. The competing ways in which the fragrant rice market is developed are explored including: Genetically Modified (GM) or Geographical Indication (GI)—with a short focus on forthcoming land use trade-offs between fragrant *versus* coarse rice cropping under water scarcity.

The Present Market of Fragrant Rice

Price of Fragrant Rice

Fragrant rice is priced on the trade market at $1,100 /T or more, whereas coarse rice is $440 - 580/T (FAO 2012). After nearly tripling to record highs between November 2007 to May 2008(Child and Kiawu 2008), global trading prices have dropped sharply. Price quotes for Thailand’s high-quality long-grain milled rice—a benchmark for global trading prices, have

declined by more than 40% since May 2008. Prices for U.S. long-grain milled rice more than doubled from November 2007 to late April 2008, and have since declined by more than 30%. By comparison, the prices of fragrant rice didn't drop, albeit declining slightly; they are always the highest from 2005 to 2012, and ranged from $825 to $1,111/T in October 2012 (see Figure 1).

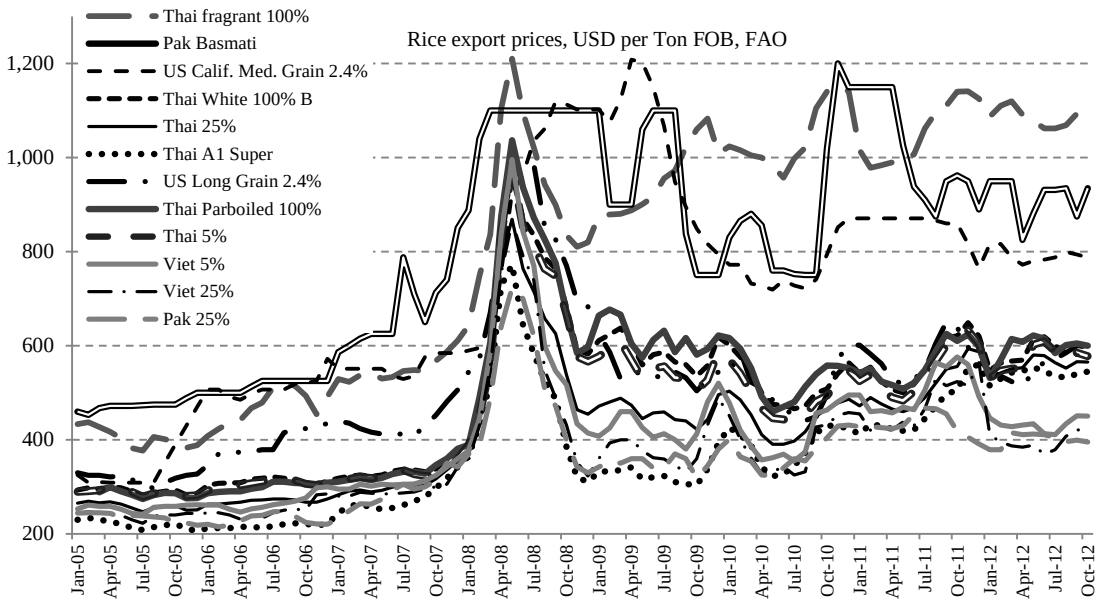

Figure 1. Rice export price, USD/T Fob, January 2005 – October 2012
Source: adapted from FAO, 2012
* %: broken grain percentage

Although unstable, the evolution of rice prices clearly shows an apparent split between the trend of specialty rice prices and the flattening of price curves for coarse rice varieties, ranging from $530 to 600/T. However, the analysis of coefficient variation, from 2005 to 2012, does not pinpoint differences within the dispersion of prices between fragrant and coarse rice categories.

Factors affecting basmati pricing seem to be related to the increasing demand from major importers and harvest variation. The dispersion of basmati's prices may be due to varying exports from both India and Pakistan. Challenging basmati prices, jasmine is higher. Jasmine pricing is sensitive to variation as it is clearly an export-oriented crop. However, the dispersion of basmati pricing is two to three times more important than jasmine. No clear differences exist between the dispersion of fragrant rice prices and coarse rice prices, apart from basmati. More generally, it was revealed that Thailand is a price maker on the rice market as it counts for a third of worldwide rice trade (Ghosray 2008). However this is not proven yet on fragrant rice segment, where basmati and jasmine are both sold with balanced influence. Although operating on the same premium segment, basmati and jasmine are not direct competitors as they address specific demands from different importers.

The price premium of fragrant rice attracts many players and increases competition between domestic and trade markets. From 2003 to 2007, domestic rice prices were often lower but close

to world prices in India and Thailand (Dawe 2008). Despite the low percentage exported from overall cropping, trade highly influences the domestic rice market through price volatility, as commodity stakeholders are prone to export when trade prices are high. Consequently, domestic rice prices are under the influence of trade prices, although 83% of rice crop is not traded (Dawe 2008). Hence frequent market shortages probably also foster fraudulent blending.

Fragrant Rice Trade

Rice trading is low and accounts for only 7.13% of the rice production, globally. Fragrant rice (mainly basmati and jasmine) is included in this production and accounts for around 15-18% of the worldwide rice trade. Fragrant rice is considered marginal in worldwide trade and largely ignored in well-documented overviews of rice marketing (Baldwin and Childs 2011; FAO 2012; Young and Wailes 2003). Basmati trade increased from 5.2% to 8.3% in all world rice trade from 2003 to 2008, with a record of 2.45 million T, on milled basis.

Recent studies have found that basmati aroma is favored by Indian-Pakistani and Turkish communities living in Europe, while jasmine addresses the sensory preferences of Asian consumers living in North America (Suwansri et al. 2002). Jasmine has low export potential for glutinous rice eating countries and is not a competitor in basmati consuming countries. Jasmine is finding a niche and growth potential in new markets for fragrant rice, where consumers do not have well established preferences (Suwannaporn and Linnemann 2008).

The WTO recognizes that governments see rice as a sensitive and special commodity (FAO 2012). Governments are able to control, and sometimes stop rice trade through taxing, governmental distribution agencies and price regulation. This exception regime is said to be leading to a safer food security system by providing lower rice prices for local populations in developing countries where authorities pay attention to rice availability for their own inhabitants. Despite holding the position as the second largest rice exporter, Vietnam chose to ban rice trade for several months in 2008 (Childs and Kiawu 2008). Egypt, India and Bangladesh did the same. Indian restrictions on non-basmati shipments were relaxed in July 2011 (FAO 2012).

The ban process did not directly affect the fragrant rice segment, as this category was not included in this ban period. In 2008, India applied a minimum export price (MEP) of $1,200/T, plus a tax of $180/T on basmati rice exports. Pakistan applied a MEP of $1,300/T for basmati rice and $1,500/T for super basmati, from January to August 2008. During the same time period, jasmine rice remained export-oriented. Jasmine accounts for 15 to 18% of Thai rice exports in volume, but contributes to half of rice exports incomes in Thailand. In 2010, India's basmati exports were estimated at 1.8 million T, Pakistan was 1.05 million T, Thailand exported 2.65 million T of perfumed rice and, Vietnam exported 0.24 million T of fragrant rice (Slayton and Muniroth 2011). These exports, identified as fragrant rice, represent 5.7 million T accounting for 18.3% of the worldwide rice trade. In Asia, trade stakeholders state that Vietnam and Cambodia garner 20 to 35% of fragrant rice market in Hong-Kong and Singapore, but receive very low prices, compared to Thai jasmine prices. However, no solid evidence of this situation is actually confirmed.

Trade of coarse rice is spread throughout several countries, with the eight first importers making 34.3% of overall rice trade. As shown in Table 1, the first six rice exporters accounted for 80.8% of overall rice trade in 2011, while they comprise 62.9% of world rice production (FAO 2012).

Table 1. Importance of the main rice producers and exporters

October 2011	Production*	rank	Export*	rank	Trade rate	Fragrant exports*
China	138.0	1	0.8	6	0.6%	
India	103.0	2	5.0	3	4.9%	1.8**
Pakistan	6.5	11	3.0	5	46.2%	1.05**
Thailand	21.2	6	8.5	1	40.1%	2.65**
USA	6.0	12	3.1	4	51.7%	
Vietnam	28.0	5	7.3	2	26.1%	0.24**
World	481.0		34.3		7.1%	5.7**

Source: adapted from FAO 2012,
* Million T
**: data 2010 from Slayton and Muniroth 2011

The fragrant rice trade is rather concentrated. In 2008, the top five clients of India have a share of 84.9%, of basmati exports from this country, those of Pakistan 68.5%, and those of Thailand 51.7% of jasmine. Basmati is primarily exported to Saudi Arabia, EU, Kuwait, Union of Arab Emirates and USA, while jasmine is shipped to China, Hong-Kong, Singapore, USA, EU and Macau. According to GDP per capita, high-quality (grains) fragrant rice is exported to rich countries, whereas fragrant broken grain is often exported to Africa, mainly the Ivory Coast, Senegal and Ghana (Slayton and Muniroth 2011).

Fragrant Rice Production

Worldwide, the paddy crop was estimated at 721 million T for 2011, producing 481 million T of milled rice, while global rice trade was estimated at 34.3 million T, on a milled basis (FAO 2012). Specific data related to fragrant rice cropping is scarce, although it comes primarily from three countries: India, Pakistan and Thailand (Chaudhary, Tran and Duffy 2003). The USA started fragrant rice's cropping in 1990, but no data is available in this special category on the well documented USDA website. Among the suppliers of the USA Rice Federation, 13 millers are providing aromatic rice. In Asia, Vietnamese and Cambodian fragrant rice is said, by trade experts, to be exported to Thailand as coarse rice. The same is likely to occur for Nepalese and Bengali fragrant rice exported to India. Since scientific publications on fragrant rice not produced in India, Pakistan or Thailand is scarce, we will primarily focus on these three countries. Rice cropping is slightly better documented.

Jasmine rice, called *Hom Mali* or *KDML 105 (Khao Dawk Mali)*, originates from the Isaan region in northeastern Thailand (Rahman et al. 2009). Released in 1959, *Hom Mali* landrace was developed during the 1980s through a governmental initiative for export purposes. The main staple for local inhabitants of the Isaan region is glutinous rice and not jasmine. Jasmine rice cropping increased by 74% from 1990 to 1998, reaching 28.3% of rice overall acreage in Thailand, despite low yields varying from 1.9 to 2.3 tons per hectare (T/ha) (Rahman et al. 2009). Jasmine rice acreage seems sensitive to export perspectives.

According to Marothia et al. (2007), fragrant rice is an oligopsony market in the farm gate. The yield from fragrant rice is independent of farm size as it is not responsive to fertilizer. Because yields are low, such rice is cropped in marginal small farms in central India. Most districts of ancient Punjab are reported to be in the basmati belt. All these regions are located in Himalayan foothills with peculiar pedo-climatic conditions and specific knowledge on traditional cropping of basmati rice (Giraud 2008). The ancient Punjab includes present western Punjab in Pakistan, eastern Punjab and Haryana in India.

In western Punjab, which represents 91.2% of all Pakistan basmati crops, basmati acreage increased by 39.7% in ten years and yield increases of 32.8%. Basmati accounted for 61.6% of rice acreage and 50.3% of the rice production in Pakistan in 2007. Basmati acreage is unknown for India and its production is estimated from 4 to 7 million T according to varying sources. Basmati yields are still low with 1.7 T/ha in 2006 in western Punjab, compared to 2.1 T/ha for all rice produced in Pakistan, and 3.8 T/ha in the eastern Punjab region of India. Cropping basmati leads to 33.1% higher costs compared to non-basmati rice in India (Uttaranchal) and 44.9% lower yields, however, according to price premiums, the net return is still positive (+30.3%) for basmati farmers (Singh et al. 2006).

As cropping areas are stabilized in the studied countries, increases in fragrant rice production depends upon yield improvement, the substitution of fragrant rice instead of coarse rice crops, and improvements in the milling process to a minor extent. According to Mushtaq and Dawson, basmati rice acreage in Pakistan is not responsive to price shocks but more sensitive to variations in irrigated areas (2002). Varietal diversity explains 25% of overall increase of rice production in Indian Punjab, while the basmati ancient variety accounts for 3.8% of rice crop in the same State (Singh 2010).

While ongoing agricultural education helps farmers use best practices in rice growing, yield improvement is mainly coming from genetic selection and crossbreeding. Agricultural development centers are working to improve rice yields and spread crop areas (Singh et al. 2006; Bashir et al. 2007; Abedullah 2007; Rahman et al. 2009). However, end-use characteristics are related to the growing place, as an effect of *terroir*. The same seeds do not provide the same final traits according to variation in planting location. Hence the trade-off is between yield improvement and preserving pure lineage in fragrant rice parentage for new varieties.

On another hand, the influence of basmati on fragrant rice market might be a concern for biodiversity. A well-documented study of fragrant rice history in India, identified 316 Indian scented cultivars, most often erased by basmati salience in cropping, and scientific works (Ahuja et al. 2008). Attractive to traders, because of its price premium, basmati rice is sown on extended acreage. Consequently, it contributes to erasing other scented cultivars which are not sold for trade.

DNA testing for had been used for some time to validate and authenticate rice (Bligh et al. 1999). Authentication for Jasmine rice does not seem to be a major issue so far as it is not a subject of recent research publications (Piyasilp and Kusanthia 2003). A survey using DNA testing was carried out in 2003 by the British Food Standards Agency in order to measure the sincerity of labeling on basmati rice packages sold in the UK (Burns, McQuillan and Woolfe 2004). One-

third of the 363 samples, collected from a range of retail outlets and catering suppliers, were labeled originating from India, one-third from Pakistan, and the final one third were not labeled from any country of origin. A small number of samples were labeled as mixed origin. All samples claimed to be basmati rice. While 54% of the samples were found to contain only basmati rice, non-basmati rice was detected in 46%. In around 24% of all the samples, the non-basmati rice content was relatively small, i.e. less than 10%, and sometimes below the limit of measurement. However 17% of samples had non-basmati rice content greater than 20%. Of great concern were 9% of the samples which contained non-basmati rice content greater than 60%. The authentication of fragrant rice is an important topic since it procures the highest prices on trade market. The rice trade consists of several players, sensitive to market pressure. The demand for fragrant rice increases slightly, while production does not always follow this trend.

Presently, some difficulties exist in distinguishing fragrant rice from coarse rice on the market. Considering the perfectible traceability of each rice shipment along the commodity chain, there is evidence of a connection between fragrant and coarse rice on trade. The major difference, coming from aroma, seems less obvious with respect to a hybridization trend currently occurring within the rice seed industry. It is likely to affect the rice market in the near future.

Rice Market Perspectives

GM or GI?

Market pressures combined with expected earnings for stakeholders have led to higher yields in the most expensive rice. So far, genetic selection has produced several hybrids that now produce a modest return of fragrant traditional lines. In a market where demand exceeds supply, stakeholders are sometimes tempted to act in an opportunistic manner. Hence, the presence of “semi-basmati” or “improved jasmine” and “product uncertainties” is found in the literature-based field studies (Goel and Bhaskaran 2007). Another issue on authentication and traceability of fragrant rice is the genetic selection and parentage of hybrid lines.

Moreover, agronomic and climatic conditions vary greatly from one region to another. Genetic selection has enabled adapted hybrids to resist water scarcity, salt abundance, high temperatures as well as weed and pest attacks. These hybrids are coming from ancient lines in a modest extent. Hence the final attributes of such hybrid lines are far from genuine traits of pure lines. Patenting living resources is still a pending issue in the fragrant rice niche with tentative international patents on *Jasmati* and *Texmati* (Sarreal et al. 1997). As the patenting trend is active, the competing scheme of GI may be better considered in order to provide a valuable tool for local biodiversity preservation. Fragrant rice is a trade-oriented commodity that attracts a number of stakeholders due to its price premium, even though they are far from the regions of origin. Hence a clarification of crop areas and seeds line varieties may enhance authenticity of fragrant rice and improve the reliability of rice commodity chain actors as well (Marie-Vivien 2008).

Although previous publications suggest an optimistic future of genetically modified rice varieties (GM), little is known about the market release of transgenic rice (Bajaj and Mohanty 2005). According to Bashir et al. (2007), several GM lines of basmati are ready in R&D laboratories,

offering different traits such as resistance to pesticide, (Bt *Bacillus thuringiensis*) cold, salinity, and bacterial blight. Notwithstanding, rice exporters are still reluctant to produce and supply GM because of averse public reactions and the potential risk of export losses in Japan and Europe (Gruère and Sengupta 2009). Because of this concern, Thailand, as the first rice exporter, is strongly reluctant to accept GM technology for rice cropping. New jasmine varieties, such as RD15 or RD6, crossbred by IRRI laboratory, are ready for market, with higher yield and better blast resistance but lower fragrance. These GM jasmine varieties are not yet released on the market, and modern crossbreeding developments are helping to improve jasmine yields without the GM technology (Jairin et al. 2009).

We will probably see a debate on GM or GI of fragrant rice in the near future. The move to register basmati as a collective trademark in Pakistan may lead to improved traceability (Mohsin 2008). Thailand initiated a registration procedure for GI in order to protect indigenous know-how on jasmine rice cropping (Saenrungmueang, Srisa-ard and Pansila 2009; Napasintuwong 2012) and jasmine rice Khao Hom Mali is a registred Protected Geographical Indication in the EU since February 2013 (European Union 2013). According to the trade orientation of fragrant rice, the GI scheme may fit well with the actual commodity chain organization that is prevailing in the rice industry. Based upon the products historical reputation of high quality and strong independent controls and compliance within code practices, the GI scheme is compatible with the important scale of production and broad marketing. Still under the free market regime, the fragrant rice trade may benefit from protecting the rice's origin in order to better anchor value in the regions of origin and to avoid misleading end-consumers. However, due to a probable GI-based segmentation on fragrant rice, a discrepancy between fragrant rice and coarse rice segments might be foreseen. Long grain coarse rice, and some fragrant GM rice varieties, may gain market share from importing countries where local consumers are more price sensitive or under the influence of strong branding strategies and less sensitive to aroma, origin or authenticity of rice.

Land Use and Water Scarcity

Another important challenge likely to develop soon is the trade-off in land use between sowing coarse rice with good yields versus sowing fragrant rice with high premium but low yields. This may influence the price making process on fragrant rice trade segment. Land use and water scarcity may affect the reliability of major rice exporters. For example, as India's domestic demand for rice increases, combined with the pressure on land and water usage, India may become an erratic rice exporter, (Kumar et al. 2010). India was the world's largest rice exporter in 2012 although it had applied a ban on coarse rice exports in 2008.

The Indian state of Punjab plans to shift agricultural activities away from water-intensive crops (rice, wheat), towards less water-intensive crops hoping for a more promising market potential. Water resource management makes Punjab's status as a grain exporter to other states increasingly problematic. One of the objectives of the governmental plan for water management in India is to reduce rice cultivation acreage in western Punjab from 2.8 to 1 million ha. As this State is the main cropping region for basmati, the implementation of this project may reduce Indian basmati production in forthcoming years. Punjab and Haryana produce 14.4% of Indian rice harvest in 2008 in a 99% irrigated area. In India, 80% of the rice production increase is related to yield

improvement, apart from Punjab where it is related to the extension of rice cropping (Prasanna, Lakshmi and Singh 2009). As Punjab is the main basmati cropping State and basmati is less sensitive to fertilizer, the Indian project for water saving could possibly lead to reduced basmati harvests.

On a global level, water usage will be a limiting factor for all rice cropping in the near future. Hence the trade-offs between coarse and specialty rice sowing will better integrate price premiums and water cost pressure as well. It remains to be seen whether this will act in favor of fragrant rice. The importation of water-intensive goods, such as rice is a water saving strategy for rich and dry countries—such as Saudi Arabia or United Arab Emirates. Such importers are able to pay for virtual water (Roth and Warner 2008).

Yield vs. Fragrance

Fragrant rice is well-known for its low yield, which produces approximately half that of coarse rice. Consequently the seed industry has sought to improve its yield and through crossbreeding of selected strains has shown promising agronomic traits. Year-after-year, new varieties of fragrant rice are released on the market which are providing better results at the harvesting stage. Stakeholders have also noticed that the fragrance of aromatic rice is becoming lighter. Thus, it is worth considering the possible effect that yield improvements have on aroma.

Since no extensive studies has been published on the cross-tabulation of agronomic and phenotypic traits of aromatic rice, a meta-analysis was conducted for the present research utilizing primary data from Akram (2009); Bhattacharjee et al. (2002); Rahman et al. (2009) and Baldwin and Childs (2011). By gathering sparse data from these studies, a dataset of 20 aromatic rice varieties was obtained on: yield; variety (T/ha); tall of observed rice plants (cm), maturity days (number of days between the date of sowing and the harvest's one); strength of the aroma (as indicated above) and year of release on the market (see Table 2)[1].

Table 2. Descriptive statistics of 20 fragrant rice varieties according to their yield, tall, maturity days, aroma and year of release

Statistics	**Yield** (T/ha)	**Tall** (cm)	**Maturity** (days)	**Aroma**	**Year of release**
mean	3.8	124.9	124.8	2.4	1987
min	0.7	90	90	1	1933
max	7.7	170	150	4	2010
std	1.45	24.18	18.68	0.88	19

A Principal Components Analysis (PCA) was carried-out in order to measure, whether the trend towards yield improvement is congruent or not with end-user oriented traits such as aroma. *Aroma* and *Year* of release on the market are discontinuous and illustrative variables; *Yield*, *Tall* and *Maturity* days are active variables. In agronomy, PCA provides useful insights for screening the crops' performance under certain conditions or traits combination (Hahn and Chae 1986; Eticha et al. 2010).

[1] The whole dataset is shown in Appendix 1.

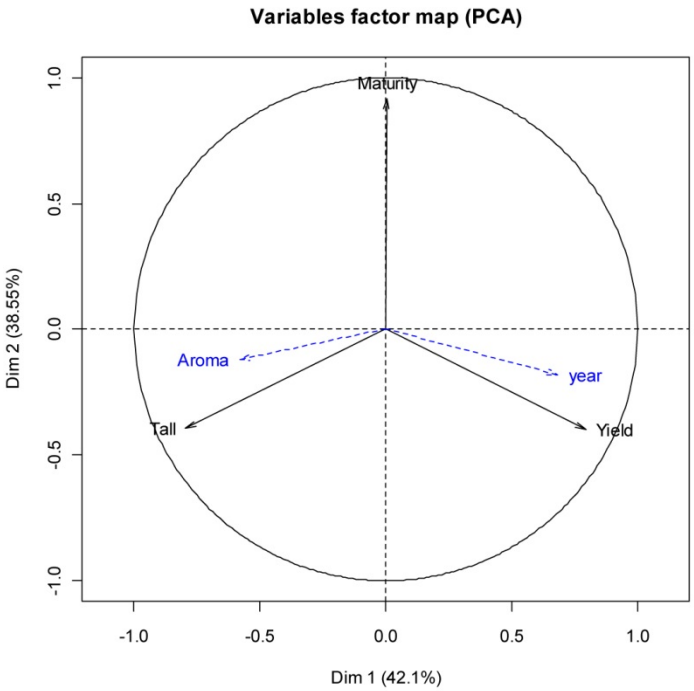

Figure 2. PCA on yield improvement vs. tall and maturity days of fragrant rice varieties
Note: Active variables are *Yield*, *Tall* and *Maturity days* in unbroken lines; illustrative variables are *Aroma* and *Year of Release* in broken line.

Figure 2 shows the results of the PCA with the 1st factor opposing *Yield* to *Tall* explaining 42.1% of the overall variance of the fragrant rice studied varieties. Meanwhile the 2nd factor is based on *days required for Maturity* and explains 38.55% of the variance. *Aroma* is an illustrative variable and is related to *Tall*. These results explain 80.65% of the overall variance within the studied dataset, and are congruent with those from Kibria, Islam and Begum (2008) who found a highly significant negative association between aroma and grain yield. The illustrative variable related to the *Yield* is the *Year* of the market release, indicating that the variety selection is leading to improved yield by decreasing the tall. The contribution of the variables to the 2nd axis indicates that the required days for *Maturity* are less correlated to the *Yield* (see Appendix 3).

The Ascendant Hierarchical Clustering (AHC) carried-out on the basis of the PCA found three classes with respectively low, medium and high yield, and interestingly, with strong and moderate aroma (see Appendix 2). The first class of fragrant rice varieties with low yield and strong aroma is the oldest one and the third class with varieties showing higher yield and lighter aroma is the most recent (see Table 3).

Compared with coarse rice, old varieties of fragrant rice are usually tall (170 cm for basmati, 140 cm for jasmine). None of the aromatic rice is known to be small. Hence, the tall of the plant is a predictor of aroma—with respect to old parentage. However, the rice plant is prone to lodge when the grains are mature and heavy. There is a risk of loss before harvest with tall plants, because once the plant is lodged, moisture and contamination by aflatoxins can occur from humid ground. Better yield is then obtained from shorter plants. As a side effect, the aroma

seems less present in new fragrant rice varieties released on the market because the primary outcome in genetic selection are yield-driven and cause reduced tall in the plant. This yield-oriented trend does not lead to a clear split between fragrant and coarse rice. The blending between these two categories becomes easier when the aromatic difference is less obvious. Consequently, rice, stated as aromatic, but including both fragrant and coarse varieties, may be shipped more frequently than pure fragrant rice.

Table 3. Descriptive statistics of 20 fragrant rice varieties according to their cluster based on Yield, Tall and Maturity days

		Active variables			**Illustrative variables**	
	Statistics	Yield (T/ha)	Tall (cm)	Maturity (days)	Aroma	Year of release
Class 1	mean	2	138	140	3	1971
	max	3	170	150	4	1996
	min	1	115	120	2	1933
	std	0.94	29.28	11.73	1.00	24.17
Class2	mean	4	128	114	2	1990
	max	5	160	140	4	2009
	min	2	91	90	1	1959
	std	0.75	19.09	15.88	0.79	14.81
Class 3	mean	5	99	137	2	1999
	max	8	116	150	2	2010
	min	4	90	121	1	1989
	std	1.64	11.81	12.71	0.50	10.15

Fragrant Rice Branding

Large variability in rice varieties is not helpful when seeking an accurate monitoring of fragrant rice production. Still questionable is the effect of crossbreeding: How often can a hybrid be crossbred and still qualify as belonging to the fragrant rice family? What is the significant lineage from pure lines for hybrid rice: 50%, 5%, or 1%? No scientific evidence is published on this, whereas some trade stakeholders are prone to label any hybrid basmati that has at least one remote lineage with basmati. The same is true for jasmine rice, and there is far from a domestic jasmine local breed in Surin (Thailand); Jasmine-Early-Short sown in Arkansas (USA), *Jasmati* patented by Rice Tec. Inc. for the North American market (Sarreal et al. 1997); or *Thasmin* cropped in Argentina.

Cropped in the USA, the fragrant rice, *Jazzman*, is a newly released variety challenging the imported jasmine from Thailand, and targets the commercial North American domestic market (Baldwin and Childs 2011). Naming this new rice *Jazzman* is quite clever. The pronunciation is close to jasmine. Jazz music comes from a major rice cropping area in USA. Hence, *Jazzman* sounds like a perfect stereotype for a rice brand in North America. Primarily, new varieties are released on the market utilizing branding and naming schemes that sound local. This practice raises the role of GI in protecting local names and local agronomic resources as well, against potential commercial abuses. This will be a major issue in the near future with the assessment of aroma as new varieties are less aromatic but still seek local parentage.

How is aroma best assessed in rice? Fragrant rice is said to have an average 2-acetyl-1-pyrroline (2-AP) content of about 150 to 400 parts per billion (ppb) (Sarreal et al. 1997). Several sources indicate that 2-AP was found as the major volatile component of rice aroma at 500-600 ng/g concentration (Lorieux et al. 1996; Buttery et al. 1983; Yoshihashi, Nguyen and Kabaki 2004).

A gas chromatography analysis identifies 72 volatile components for basmati aroma (Tava and Bocchi 1999). Despite the availability of an accurate method, the ways used to assess aroma along the commodity chain are rather simple. According to Maraval et al. (2008), the method for aroma assessment in rice was first developed by International Rice Research Institute (IRRI) in 1971. A basic laboratory technique is utilized which includes one gram of freshly harvested milled rice is placed into a centrifuge tube (50 mL, round bottom) and 20 mL of distilled water is added. The tubes are then covered with aluminum foil. The samples are placed in a boiling water bath for 10 minutes. The cooked samples are allowed to cool and the presence of aroma is determined for every sample by sniffing. Brown rice may also be used with the cooking time increased to 30 min. The samples are scored as *strongly aromatic*, *moderately aromatic*, *slightly aromatic*, and *non-aromatic*. A strongly scented variety is used as a check for comparison. Akram (2009) shows a binary scale for aroma (*strong*, *moderately strong*), but it is still very subjective. The Thai agricultural standard for fragrant rice defines aroma test for jasmine by "*boiling in salt solution and smelling*" (Kongsere 2008).

Surprisingly, the assessment of rice fragrance is still rather empirical, while robust methods of characterization do exist. However, the end-market evolution towards ready-to-eat meals does not lead consumers to identifying rice based on its genuine aroma when microwaveable seasoned rice methods are utilized in favor of the 20 minutes required for cooking pure fragrant rice. Nowadays, rice is primarily sold to end-users in plastic bags for safety and hygiene reasons. Consequently the aroma of fragrant rice is not a distinctive attribute for choice when purchasing before cooking. End-consumers in USA and Europe are less familiar with aroma of fragrant rice.

To summarize, the difference between coarse and fragrant rice is not obvious. The quality of the rice is measured by the rate of broken grains, whether they are aromatic or not. Genetic selection is providing new varieties with higher yields and less aroma. The level of aroma *per se* is assessed through a very simple and insufficiently codified method, allowing a broad range of subjective statements of what is fragrant rice. These trends give an implicit signal to collectors, traders, and millers: mixing different varieties of rice is not that illicit as far as it allows providing the always demanding world market with the required quantity and quality, in due time.

Trade-Oriented Sources

When looking for specialty rice, data on the trade is often available on the Internet, while data on the crop is by far less salient. Data on fragrant rice is mainly provided by trade sources (Ministry of Commerce in India and Thailand and rice exporters association in Pakistan), whereas agricultural ministries are supposed to have such databases. Overall fragrant rice production, for both export and domestic usage, is still unknown as data on the crop is not available. The most recent data on fragrant rice exports is sourced from the commodity chain stakeholders (country's board of trade) gathered by experts (Slayton and Muniroth 2011).

Due to a great variety of rice formats, the comparison of price/weight ratio is difficult when data is available on paddy, brown, husked, milled, parboiled or broken rice. Rice's loss in weight varies from 10% to 37% according to variety, cropping area and the type of machinery utilized during the harvesting, processing and packaging stages along the commodity chain (Bhattacharjee, Singhal and Kulkarni 2002). The first month for recording the rice campaign in Thailand is January, April in India, and July in Pakistan. Large databases from the FAO or USDA do not distinguish fragrant from coarse rice, except for price monitoring.

A comparative overview of databases presents a frustrating trade-off when analyzing global data. Discrepancies exist among recent data versus more detailed but older information. Erratic discrepancies exist between public and private sources—for the same year and same country. Our research found data scarcity and heterogeneity for this niche market. As a trade-oriented commodity, fragrant rice generates more data in value rather than in volume, making room for great permeability between fragrant and coarse rice production. This is an enlightening issue with respect to our research question: Will fragrant and coarse rice segments have the same future on trade?

Conclusion

The observations outlined in this paper provide a suitable orientation toward helping design a better future for the fragrant rice sector. While coarse rice is related to food security in cropping countries, fragrant rice is a trade-oriented commodity. Hence, the same regulations do not work with both rice categories. The export standards in India, Pakistan and Thailand, should be revised and rapidly implemented. Clean and fair practices should be promoted throughout the fragrant rice commodity chain in order to prevent the blending of coarse and fragrant rice. A noticeable split between coarse rice, as a commodity for usual markets, and fragrant rice as a specialty niche and valued market should be considered, as mentioned above. Price volatility may be the basic scenario for coarse rice, according to harvest variations and persistent high domestic demand in the main rice producing countries. For fragrant rice, high price might be the baseline with respect to stable increase of demand from rich importing countries.

In Thailand, fragrant rice is not a staple of the local diet; therefore fragrant rice production is mainly dependent upon trade policy. In India, where inhabitants are fragrant rice eaters, rice cropping is a strategic and sensitive issue with respect to food sovereignty; hence food policy may take the lead. However trade policy is also relevant as India's fragrant rice is not only a rich cultural heritage but also a trade-oriented commodity. In Pakistan, rice belongs to both the local diet and business trade, so food and trade policies should agree to compromise. Pakistani consumers are mainly wheat eaters, but their cultural identity includes basmati as staple food. For new players, such as USA, fragrant rice cropping is a rising issue for food sovereignty; for others, such as Vietnam and Cambodia, fragrant rice may be considered as a good trade opportunity, underlying the needs of a reliable commodity logistics chain.

Fragrant rice will not remain a quiet niche market; regardless of stability, price increases are foreseen (see Figure 4).

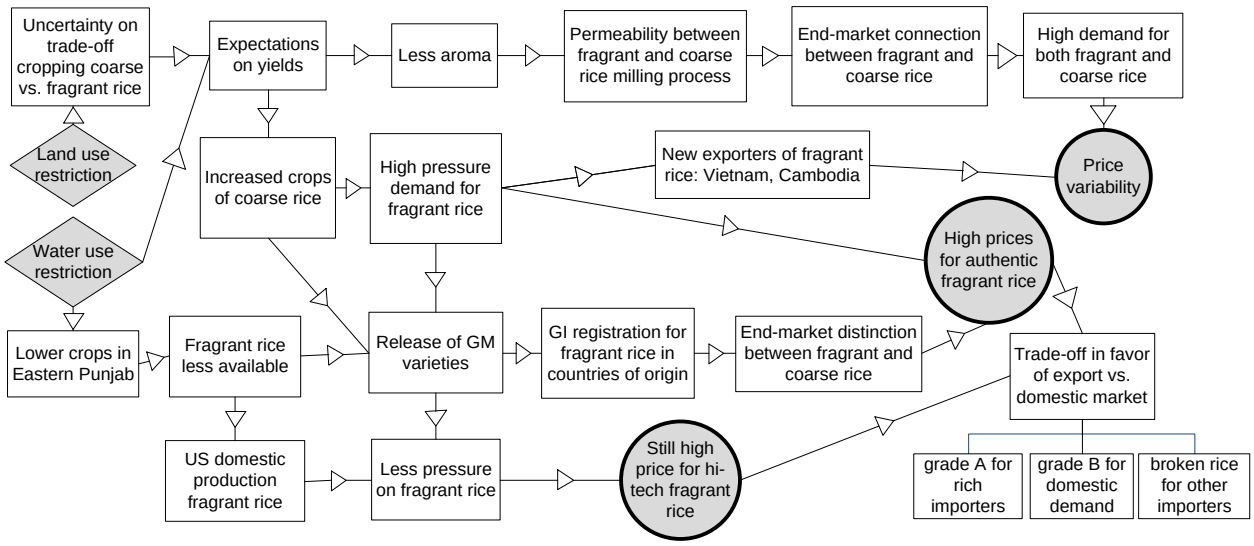

Figure 4. Scenarios for fragrant rice: between split and connection with coarse rice

Returning to our initial research question, we conclude that the forthcoming competition related to water scarcity issues between coarse rice with high yield and fragrant rice with low yield will probably lead to lower fragrant rice cropping or the development of new fragrant varieties with higher yields and less aroma. This scenario is the end-market connection between fragrant and coarse rice segments and like other commodities, involves price variability. A second possible scenario may occur with the release of GM varieties designed to fill the gap between the low production of fragrant rice and its high demand. In such a case, a split may occur between coarse and fragrant rice, with still higher pricing for hi-tech fragrant rice, despite this new production. The stakeholder's reaction to both fraudulent blending of non-fragrant rice and release of GM fragrant rice on the market may lead to a third scenario positioned between the first two. Hence GI registration may speed-up for both jasmine and basmati. This scenario may favor a new segmentation between GM, GI, and blended fragrant rice, with the related price matrix. Albeit more probable, the outcome of the split is not totally known between fragrant and coarse rice on trade. To be defined, this forecast needs further investigations into the cropping, trading and shipping aspects of both coarse and fragrant rice.

References

Abedullah, K.S. and K. Mushtaq. 2007. Analysis of Technical Efficiency of Rice Production in Punjab (Pakistan). *Pakistan Economic and Social Review* 45(2): winter 231-244.

Ahuja, U., S.C. Ahuja, R. Thakrar and N.S. Rani. 2008. Scented Rices of India. *Asian Agri-History* 12(4): 267-283.

Akram, M. 2009. Aromatic Rices of Pakistan, a Review. *Pakistan Journal of Agricultural Research* 22(3-4): 154-160.

Bajaj, S. and A. Mohanty. 2005. Recent Advances in Rice Biotechnology, Towards Genetically Superior Transgenic Rice. *Plant Biotechnology Journal* 3: 275-307.

Baldwin, K. and N. Childs. 2011. *2009/10 Rice Yearbook*. ERS USDA RCS-2010 January 24.

Bashir, K., N.M. Khan, S. Rasheed and M. Salim. 2007. Indica Rice Varietal Development in Pakistan: an Overview. *Paddy Water Environment* 5: 73-81.

Bhattacharjee, P., S.R. Singhal and P.R. Kulkarni. 2002. Basmati Rice: a Review. *International Journal of Food Science and Technology* 37: 1-12.

Bligh, H.F.J., N.W. Blackhall, K.J. Edwards and A.M. McClung. 1999. Using Amplified Fragment Length Polymorphisms and Simple Sequence Length Polymorphisms to Identify Cultivars of Brown and White Milled Rice. *Crop Science* 39: 1715-1721.

Burns, J., M. McQuillan and M. Woolfe. 2004. *Survey on Basmati Rice*. Food Standards Agency, report 47.04 March 29.

Buttery, R.G., L.C. Ling, B.O. Juliano and J.G. Turnbaugh. 1983. Cooked Rice Aroma and 2-acetyl-1-pyrroline. *Journal of Agriculture and Food Chemistry* 31(4): 823–826.

Chaudhary, D., D.V. Tran and R. Duffy. 2003. *Specialty Rices of the World: Breeding Production and Marketing*. FAO books, Roma, 358.

Childs, N. and J. Kiawu. 2009. *Factors Behind the Rise in Global Rice Prices in 2008*. RCS-09D-01, ERS USA, May 25.

Dawe, D. 2008. *Have Recent Increases in International Cereal Prices Been Transmitted to Domestic Economies? The Experience in Seven Large Asian Countries*. FAO ESA working paper (08-03): 11.

Eticha, F., H. Grausgruber and E. Berghoffer. 2010. Multivariate Analysis of Agronomic and Quality Traits of Hull-less Spring Barley (*Hordeum vulgare L.*). *J[al] of Plant Breeding and Crop Science*, vol. 2(5): 81-95.

European Union. 2013. Regulation n°120/2013, Khao Hom Mali Thung Kula Rong-Hai registred as PGI. *Official Journal of the European Union* L41 February 12: 3-8.

FAO. 2012. *Rice Market Monitor.* XV (4): November 37.

Ghosray, A. 2008. Asymmetric Adjustment of Rice Export Prices: The Case of Thailand and Vietnam. *International Journal of Applied Economics* 5(2): 80-91.

Giraud, G. 2008. Range and Limit of Geographical Indication Scheme: the Case of Basmati Rice from Punjab, Pakistan. *International Food and Agribusiness Management Review* 11(1): 51-76.

Goel, V. and S. Bhaskaran. 2007. Marketing Practices and Distribution System of Rice in Punjab, India. *Journal of International Food & Agribusiness Marketing* 19(1): 103-135.

Gruère, G. and D. Sengupta. 2009. GM-free Private Standards and Their Effects on Biosafety Decision-Making in Developing Countries. *Food Policy* 34: 399-406.

Hahn, W.S. and Y.A. Chae. 1986. Principal Component Analysis for the Growth Data of Rice. *Korean J[al] of Crop Science* 31(2): 173-178.

Jairin J., S. Teangdeerith, P. Leelagud, J. Kothcharerk, K. Sansen and M. Yi. 2009. Development of Rice Introgression Lines with Brown Plant Hopper Resistance and KDML 105 Grain Quality Characteristics Through Marker-assisted Selection. *Field Crops Research* 110: 263-271.

Kibria, K., M.M. Islam and S.N. Begum. 2008. Screening of Aromatic Rice Lines by Phenotypic and Molecular Markers. *Bangladesh Journal of Botanic* 37(2): 141-147.

Kongsere, N. 2008. Thai Aromatic Rice, Thai Agricultural Standard. TAS 4001-2008. *Royal Gazette* 125 (139D) 26 p.

Kumar, P., P. Shinoj, S.S. Raju, A. Kumar, K.M. Rich and S. Msangi. 2010. Factor Demand, Output Supply Elasticities and Supply Projections for Major Crops of India. *Agricultural Economics Research Review* 23: 1-14.

Lorieux, M., M. Petrov, N. Huang, E. Guiderdoni and A. Ghesquière. 1996. Aroma in Rice: Genetic Analysis of a Quantitative Trait. *Theoretical and Applied Genetics* 93: 1145-1151.

Maraval, I., C. Mestres, K. Pernin, F. Ribeyre, F. Boulanger, E. Guichard and Z. Gunata. 2008. Odor-Active Compounds in Cooked Rice Cultivars from Camargue (France) Analyzed by GC-O and GC-MS. *Journal of Agriculture and Food Chemistry* 56(13): 5291–5298.

Marie-Vivien, D. 2008. From Plant Variety Definition to Geographical Indication Protection: A Search for the Link Between Basmati Rice and India/Pakistan. *The Journal of World Intellectual Property* 11(4): 312-344.

Marothia, D.K., R. K. Singh, M.R. Chandrakar and B.C. Jain. 2007. Economics and Marketing of Aromatic Rice, A Case Study of Chhattisgarh. *Agricultural Economics Research Review* 20 (January-June): 29-46.

Mohsin, M. 2008. *Registration of Basmati as a GI Trademark*. Trade Marks Registry, Government of Pakistan. (May 10):4.

Mushtaq, K. and P.J. Dawson. 2002. Acreage Response in Pakistan: a Co-integration Approach. *Agricultural Economics* 27: August 111-121.

Napasintuwong, O. 2012. Survey of Recent Innovations in Aromatic Rice. 131th EAAE Seminar *Innovation for Agricultural Competitiveness and Sustainability of Rural Areas*, Prague, September 18-19.

Piyasilp, B. and A. Kusanthia. 2003. *Local Rice Genetic-diversity in Northeastern Thailand. Rice Farming: Best practices*. CIP-UPWARD, 104-115.

Prasanna, P.A., S. K. Lakshmi and A. Singh. 2009. Rice Production in India - Implications of Land Inequity and Market Imperfections. *Agricultural Economics Research Review* 22: 431-442.

Rahman, S., A. Wiboonpongse, S. Sriboonchitta and Y. Chaovanapoonphol. 2009. Production Efficiency of Jasmine Rice Producers in Northern and North-Eastern Thailand. *Journal of Agricultural Economics* 60(2): 419-435.

Roth, D. and J. Warner. 2008. Virtual Water: Virtuous Impact? The Unsteady State of Virtual Water. *Agriculture and Human Values* 25: 257-270.

Saenrungmueang, W., K. Srisa-ard and V. Pansila. 2009. Indigenous Knowledge for Khao Hom Mali Rice Production and Development for Export in the Thung Kula Rong Hai Plain. *The Social Sciences* 4(1): 65-70.

Sarreal, E.S., J.A. Mann, J.E. Stroike and R.D. Andrews. 1997. *Basmati Rice Lines and Grains Patent # 5,663,484*. United States Patent.

Singh, H.N., U.S. Singh, R.K. Singh, V.K. Singh, S.P. Singh and S.C. Mani. 2006. Adoption Pattern and Constraints Analysis of Basmati Rice: Implications for Enhancing Adoption and Stabilizing Productivity in Uttaranchal, India. *Indian Journal of Crop Science* 1(2): 106-108.

Singh, J. 2010. Genetic Diversity for Sustainability of Rice Crop in Indian Punjab and its Implications. *Journal of Plant Breeding and Crop Science* 2(9): 293-298.

Singh, R.K., U.S. Singh and G.S. Khush eds. 2000. *Aromatic Rices*. Oxford & IBH Publ., 283.

Slayton, T. and S. Muniroth. 2011. *A More Detailed Road Map for Cambodian Rice Exports.* World Bank working paper, 36. www.scribd.com/doc/72688312/x10712-Cambodia-Rice-Road-Map.

Suwannaporn, P. and A. Linnemann. 2008. Consumer Preferences and Buying Criteria in Rice: A Study to Identify Market Strategy for Thailand Jasmine Rice Export. *Journal of Food Products Marketing* 14(4): 33-53.

Suwansri, S., J.F. Meullenet, J.A. Hankins and K. Griffin. 2002. Preference Mapping of Domestic/Imported Jasmine Rice for US-Asian Consumers. *Journal of Food Science* 67(6): 2420-2431.

Tava, A. and S. Bochi. 1999. Aroma of Cooked Rice (*Oryza sativa*): Comparison Between Commercial Basmati and Italian Line B5-3. *Cereal Chemistry* 76(4): 526-529.

Timmer, C.P. 2010. *The Changing Role of Rice in Asia's Food Security*. Asian Development Bank, Working paper series, 15, September, 19.

Yoshihashi, T., T.T.H. Nguyen and N. Kabaki. 2004. Area Dependency of 2-acetyl-1-pyrroline Content in an Aromatic Rice Variety, Khao Dawk Mali 105. *Japan Agricultural Research Quarterly* 38: 105-109.

Young, K.B. and E.J. Wailes. 2003. *Rice Marketing.* In Smith C.W. and R.H. Dilday eds., *Rice: Origin, History, Technology, and Production*. J. Wiley press: 473-488.

Databases

FAO: http://www.fao.org/economic/est/publications/rice-publications/rice-market-monitor-rmm/en/
USDA: http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1286
Pakistan: http://reap.com.pk/download/index.asp
India: http://commerce.nic.in/eidb/default.asp basmati code 10063020
Thailand: http://www2.ops3.moc.go.th/ jasmine code 10063040

Appendix 1.

Table 4. Fragrant rice -related characters according to variety

Variety	**Yield** (T/ha)	**Tall** (cm)	**Maturity** (days)	**Aroma**	**Year of release**
Basmati 370	2.5	170	140	4	1933
Hom Mali KDML105	4.1	140	140	4	1959
Basmati Pak	2.0	170	120	4	1968
Basmati 198	3.0	139	130	2	1972
Dehradoon Basmati	3.3	115	150	3	1973
Kashmir Basmati	4.4	160	90	3	1977
Basmati 217	0.7	120	145	2	1987
Basmati 385	4.0	130	112	3	1988
Kasturi Basmati	4.0	102	125	1	1989
Pusa Basmati 1	4.0	90	150	2	1989
Haryana Basmati	4.5	116	143	1	1991
Khushboo 95	4.4	130	114	2	1996
Super Basmati	3.4	115	117	2	1996
Taraori Basmati	2.5	115	145	2	1996
Rachna Basmati	4.2	135	95	2	1999
Basmati-2000	4.5	135	115	2	2000
Shaheen Basmati	4.5	134	120	2	2001
Mahi Sugandh Basmati	5.3	92	132	2	2004
Jasmine Early Short	2.1	91	92	2	2009
Jazzman	7.7	99	121	2	2010

Source: Adapted from Akram 2009, Bhattacharjee et al. 2002, Rahman et al. 2009 and Baldwin and Childs, 2011

Appendix 2.

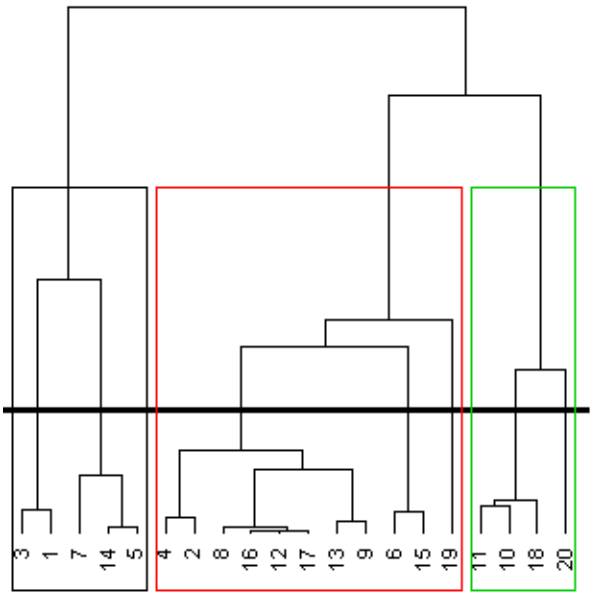

Figure 5. Ascendant hierarchical clustering on yield, tall and maturity days of fragrant rice varieties

Appendix 3.

Table 5. PCA results on yield improvement vs. tall and maturity days of 20 fragrant rice

Axis	**Eigen values**	**% explained**	**% cumulated**
1	1.26	42.10	42.10
2	1.16	38.55	80.65
3	0.58	19.35	100
variable coordinates	**axis 1**	**axis 2**	**axis 3**
Yield	0.79344462	-0.3989993	0.4596142
Tall	-0.7958337	-0.3938032	0.4599649
Maturity	0.00346721	0.917725	0.3972011
cos^2			
Yield	0.62955	0.15920	0.21125
Tall	0.63335	0.15508	0.21157
Maturity	0.00001	0.84222	0.15777
variable contribution			
Yield	49.85	13.77	36.39
Tall	50.15	13.41	36.44
Maturity	0.00	72.82	27.17