IRRI

INTERNATIONAL RICE RESEARCH INSTITUTE

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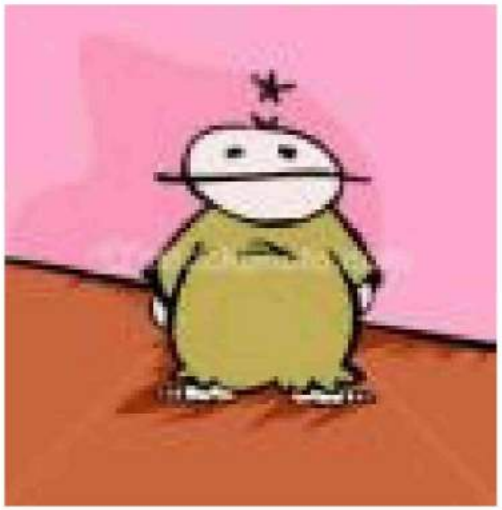
Basmati and Quality and Questions

Rice Science for a Better World

International Network for Quality Rice

Disclaimer

Some of the things I will say are from trusted sources.
I will say some things to promote discussion and not to offend.



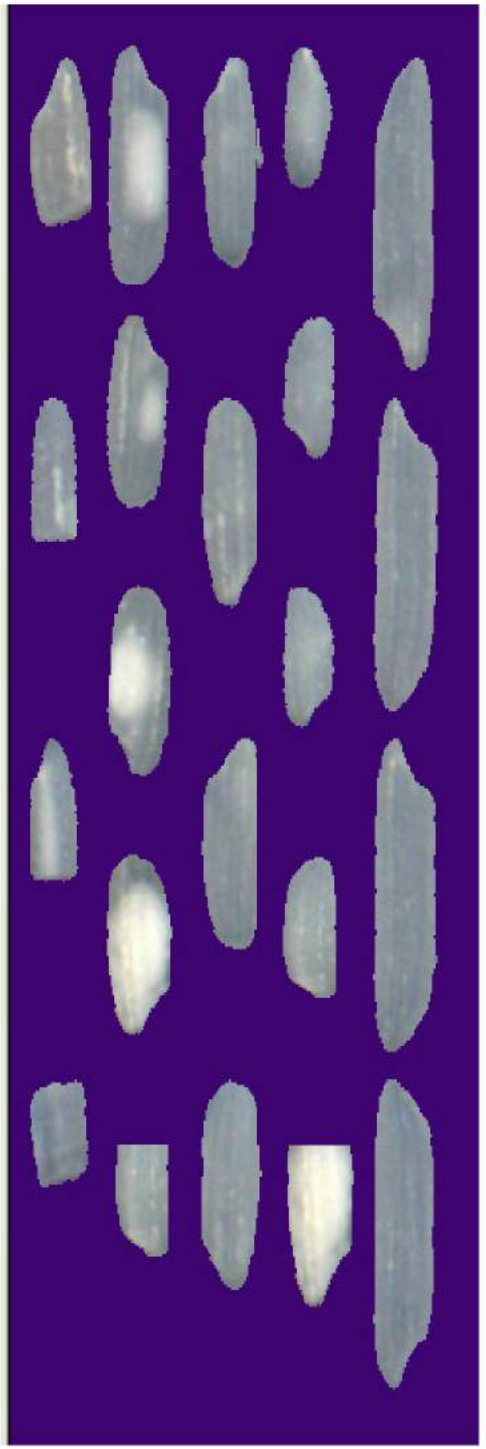
Quality Traits

Physical

- Chalk
- Colour
- Head rice yield
- Size and shape

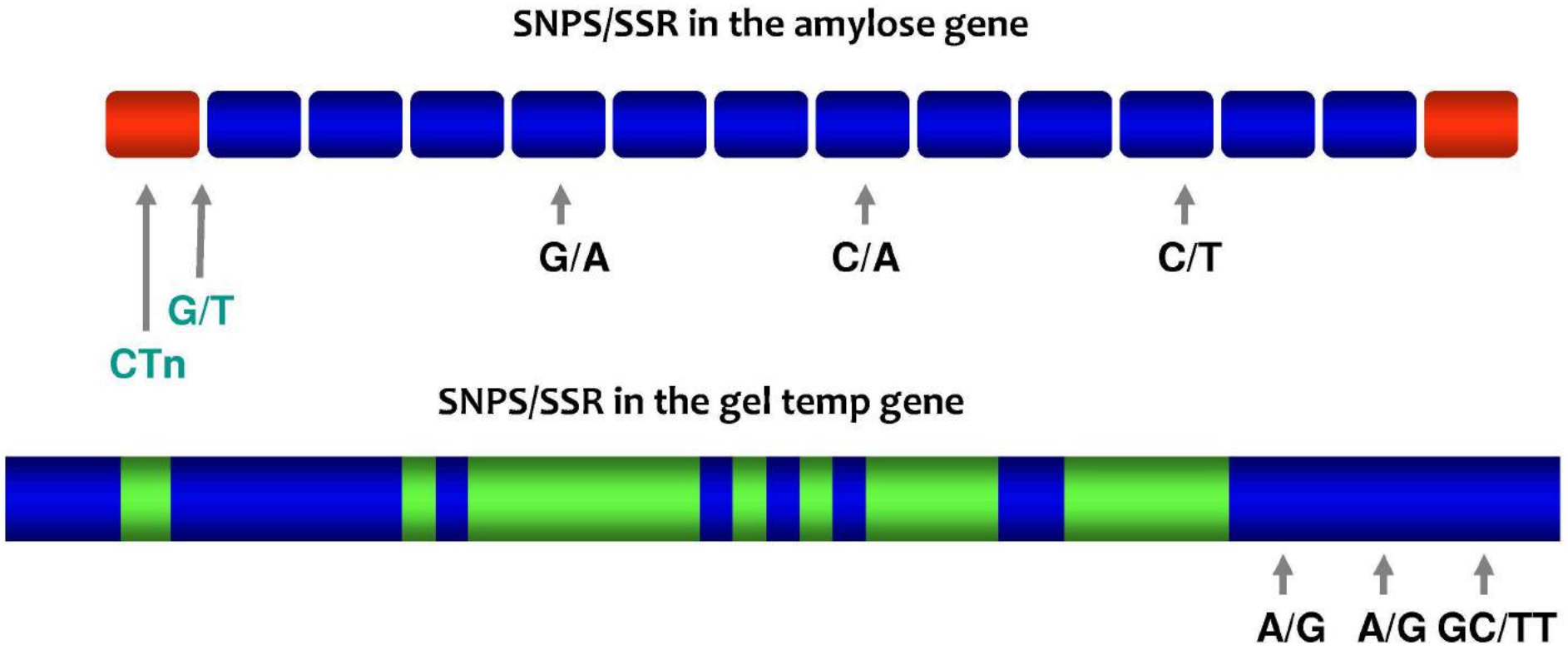
Sensory

- Amylose content
- Aroma
- Gel temperature
- Gel consistency
- Texture



SSR markers of quality

- SSR and 4 SNPs on the waxy gene (responsible for amylose).
- 4 SNPs in the gene that contributes significantly to gelatinisation temperature.
- SNP that separates high Gel Con from low Gel Con.
- SNPs, insertions and deletions on the fragrance gene.



PCR markers available to genotype each mutation.

Different mutations in the fragrance gene

Allele	Mutation	N	Subpopulation	Avg [2AP]
Wild Type		149	ALL	< 0.05
badh2.1		93	Group I, V, VII	0.70 ± 0.41
badh2.2		1	Group VII	0.66
badh2.3		1	Group VII	0.74
badh2.4		1	Group VII	0.59
badh2.5		1	Group I	0.70
badh2.6		1	Group II	0.41
badh2.7		6	Group II	0.43 ± 0.17
badh2.8		5	Group V	0.61 ± 0.45
badh2.9		6	Group VII	0.16± 0.05
badh2.10		2	Group VII	0.35

Kovach, Calingacion, Fitzgerald and McCouch, 2009: PNAS

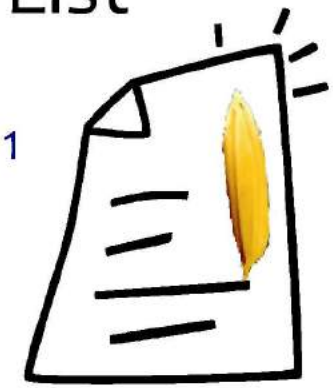
Basmati Quality

- Grain must be > 6.5 mm and slender;
- Grain must elongate to twice the length on cooking without expanding width-wise;
- Amylose content, gel consistency and gelatinisation temperature must be intermediate;
- Grain must be aromatic.

Discriminating Basmatis

- Selected 500 samples from the genebank that were submitted as basmati including those on the EU list and putative aromatic adulterants.
- Carried out morphological assessment during plant growth for basmati plant type and quality analysis of grains for all traits.
- Genotyped grain for amylose, gel temp, gel consistency and aroma.

The 11 varieties on the B List

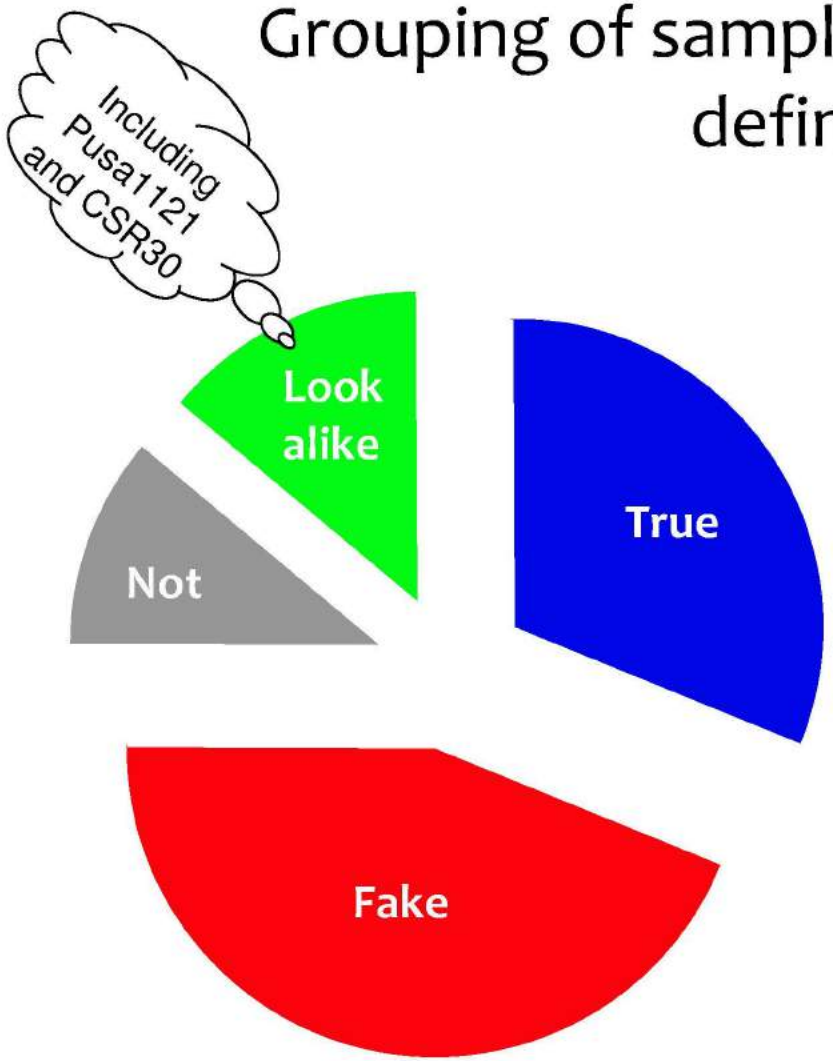


- Pusa basmati 1
- Type 3
- Super
- Basmati 217
- Basmati 386
- Taraori Basmati (HBC -19)
- Ranbir basmati
- Basmati 370
- Kernel Basmati
- Kasturi (IET 8580)
- Mahi Suganda

Suspects for adulteration

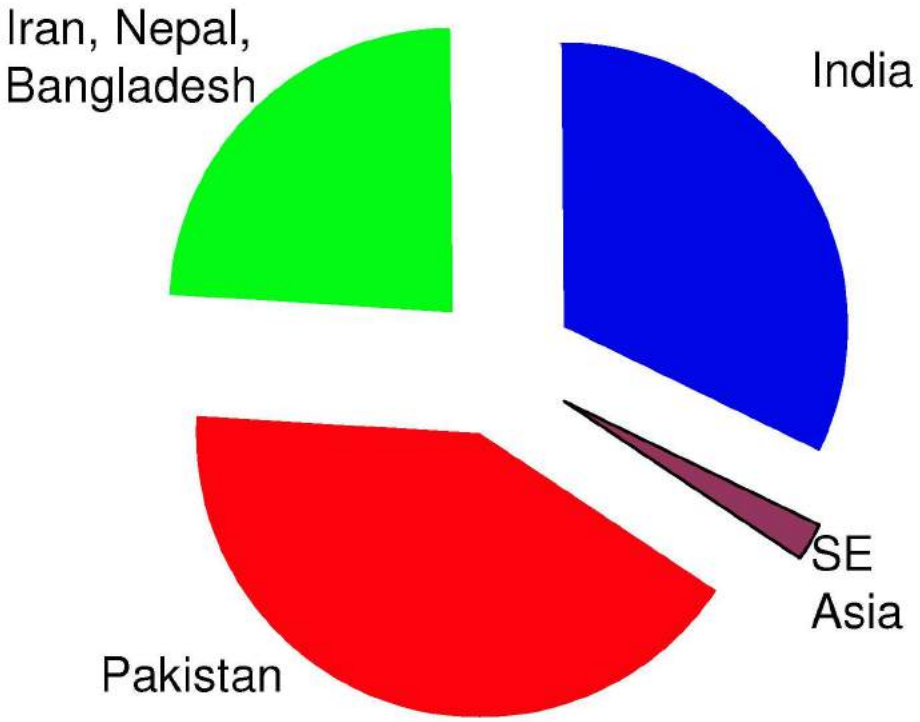
- Pusa 1121
- Yamini (CSR30)
- Basmati 385
- Basmati 2000
- Vasumathi
- Basmati 198
- PR106
- IR64
- PR11
- IR6
- KS282

Grouping of samples based on UPOV criteria defining Basmati



- 500 samples analysed for morphological traits of the plant and grain quality traits and grain quality genotypes.
- Many samples called basmati did not meet the criteria for basmati (fake).
- Many not called basmati did meet those criteria (look alike).

Geographic origin of the 'true' and 'look-alike' basmati

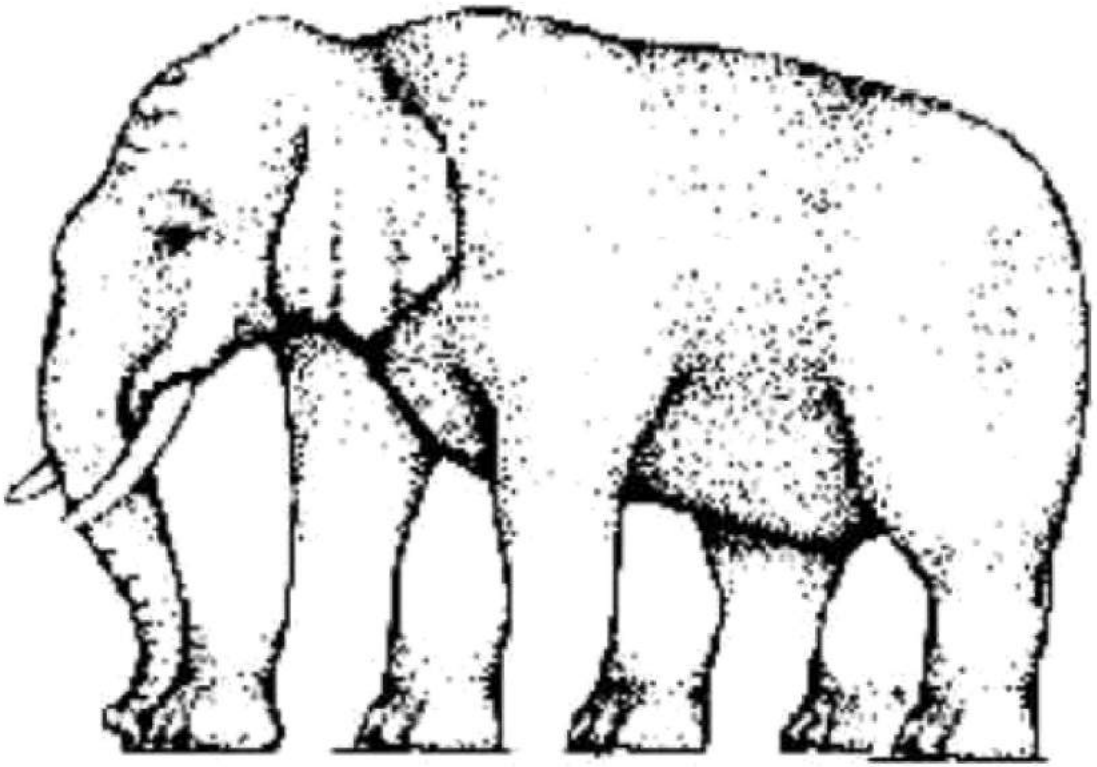


- Samples that carry all defined basmati morphological and quality traits are not just found in India and Pakistan.
- It would require other tools to discriminate rice grown in the GI area at the right time from those grown elsewhere….

UPOV type descriptors

- By following UPOV descriptors for plant and grain features, traditional basmati types and those on the EU list cannot be discriminated from either potential adulterants or from many other types of rice.
- Known mutations in genes of quality do not separate basmati types from non-basmati types either.

Some interesting facts..
Is all as it appears???



The Rice Life Cycle

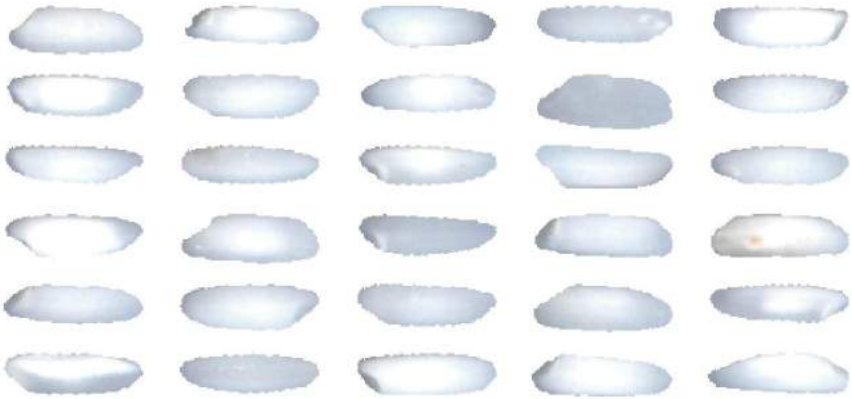
- Breeding program releases pure seed to farmers.
- Farmers grow the seed and sell grain to traders – probably still quite pure.

- And then the traders …… do their thing and finally it reaches consumers.

Those two varieties are both the same size and shape…

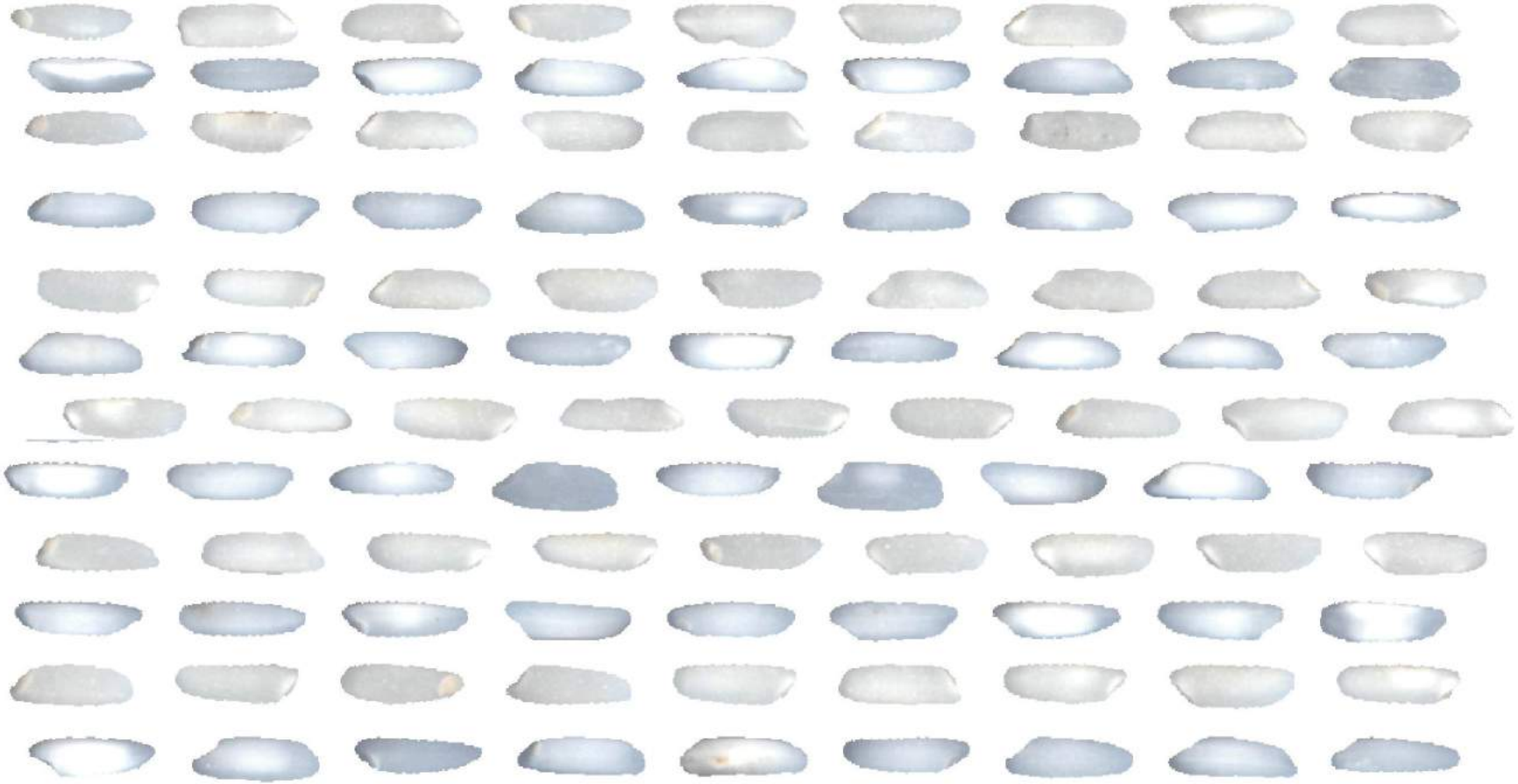
IR1
Nice looking grain, not very chalky.

IR2
This sample is very chalky.

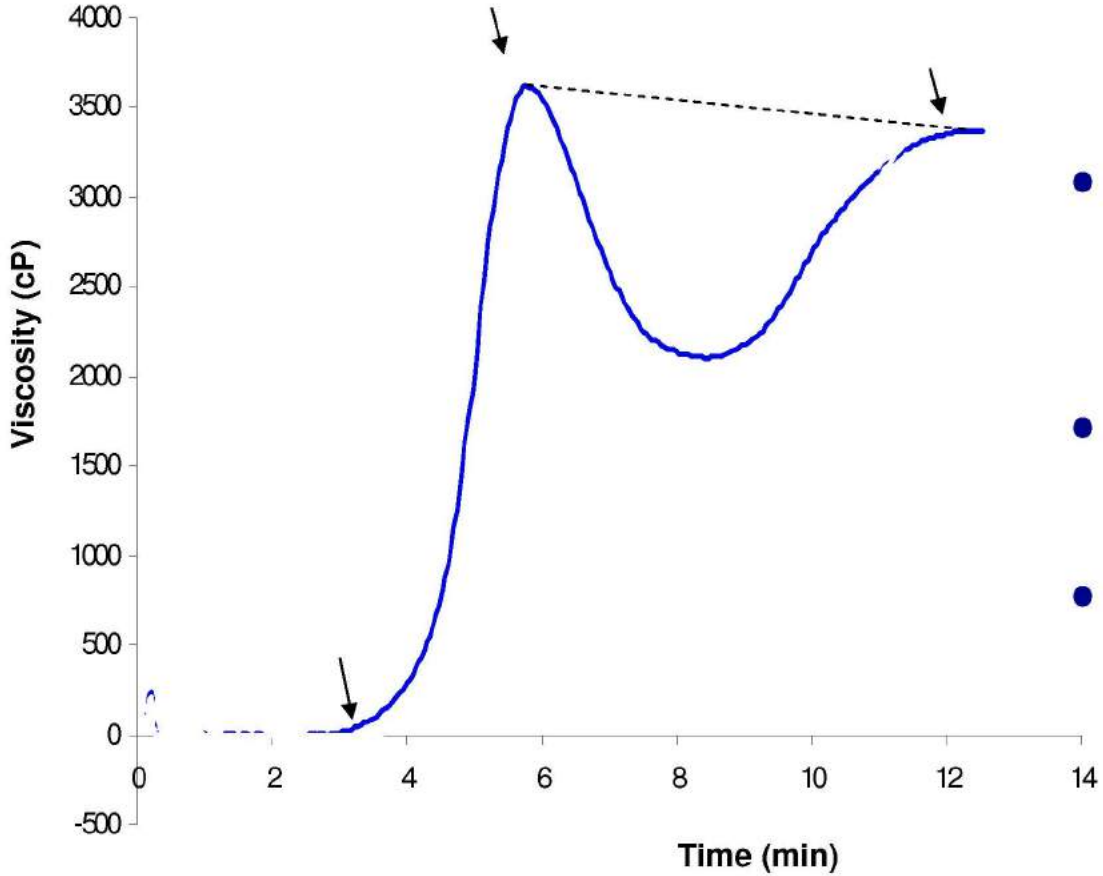


% chalk determines the price at market.

Traders blend based on shape, reducing chalk from 14 – 4% (US grade 2).

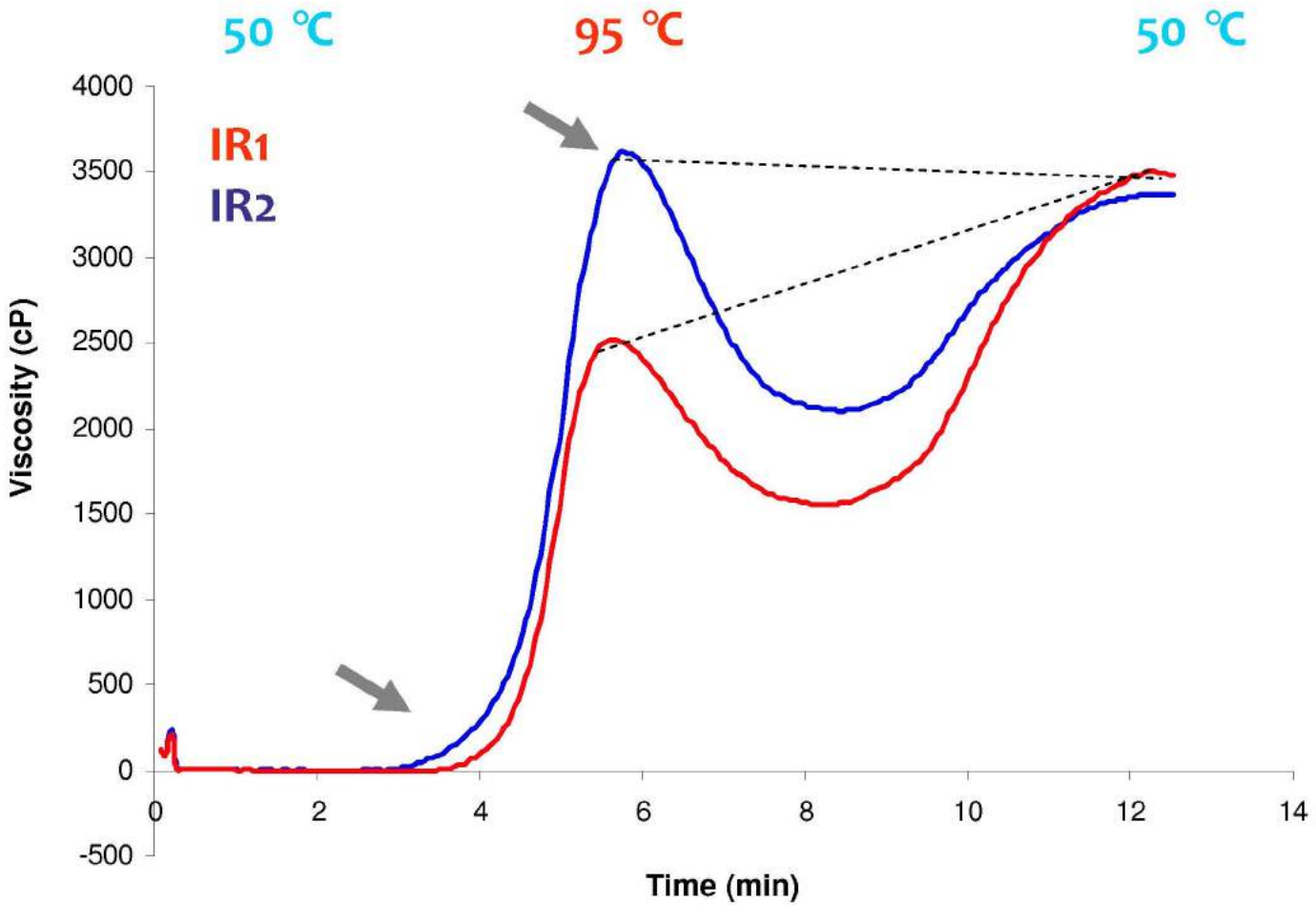


A test that indicates cooking quality

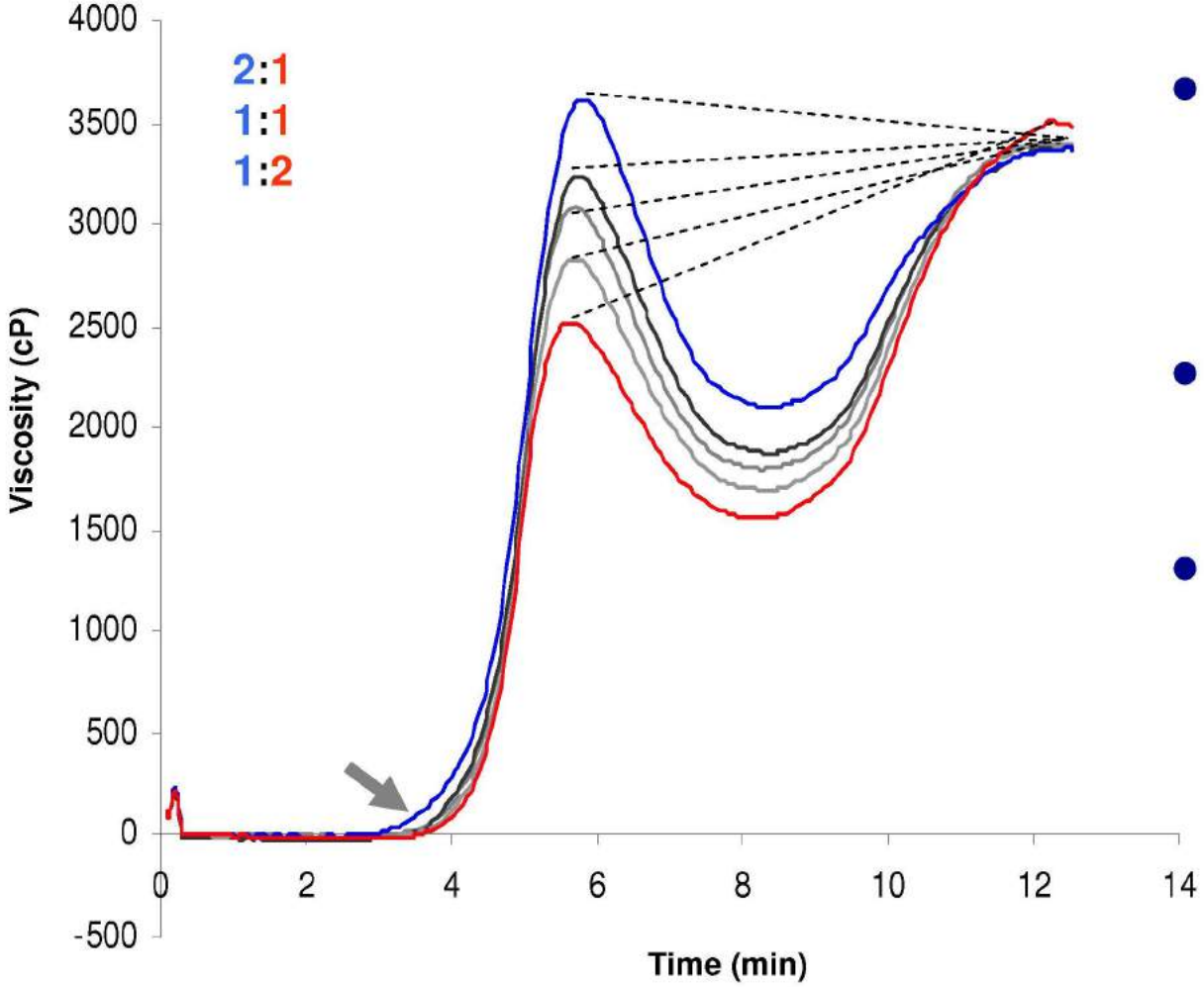


- Pasting temperature – indicates when the rice begins to cook
- Peak viscosity, indicates how the rice swells for processing
- Final viscosity indicates how firm the rice will be
- FV-PV indicates how firm the rice will be

Testing viscosity-these varieties cook completely differently

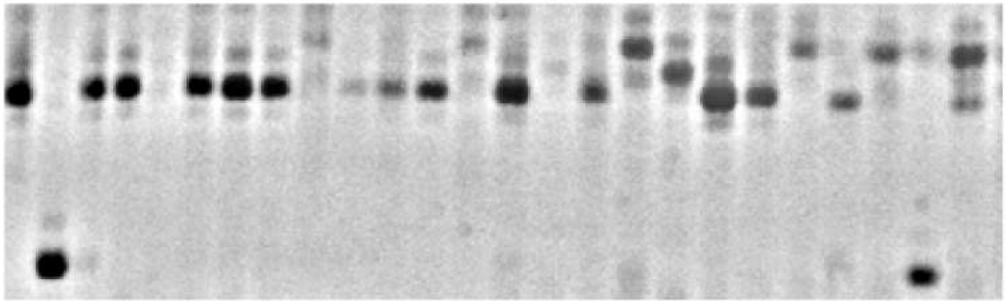


Different blends change eating quality…



- Pasting temperature has changed.
- FV-PV has changed. So…..
- Processing and sensory properties have completely changed.

Commercial sample of Basmati



- DNA extracted from single grains.
- Marker is a polymorphic SSR on the gene responsible for amylose synthesis.
- 4 different varieties in this bag of rice.

Mathematics in 2004

- In 2004 0.6 MT of EU list types were grown in India but 0.8 MT of EU list types were exported……
- 3 MT evolved basmatis grown…..
- The quality of the evolved and traditional cannot be distinguished by current quality evaluation tools.

Mathematics 2008

1) 368 000 tonnes polished rice exported to the EU.
= about 1 million tonnes paddy (40% head rice yield).

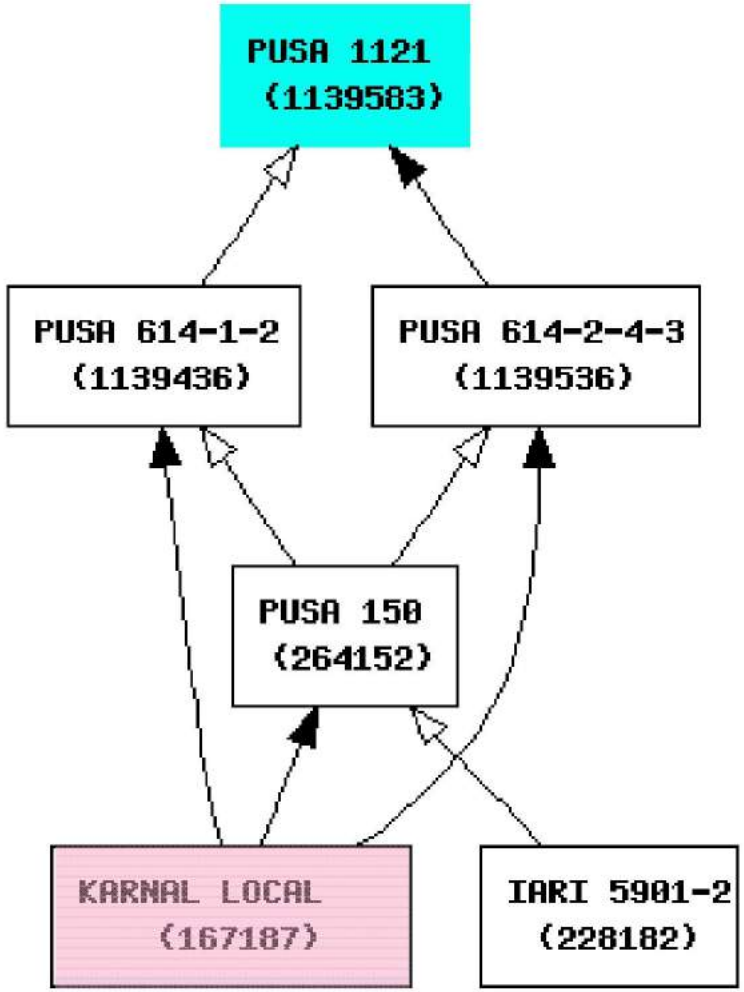
2) Traditional varieties yield about 2 tonnes paddy/hectare.

3) At least 500 hectares required to grow a million tonnes of paddy.

4) 1.5 million hectares of area in the GI location for growing basmati and one season per year.

5) More than 60% is sown to Pusa 1121 and about 30% sown to CSR30 – where is the EU basmati grown?

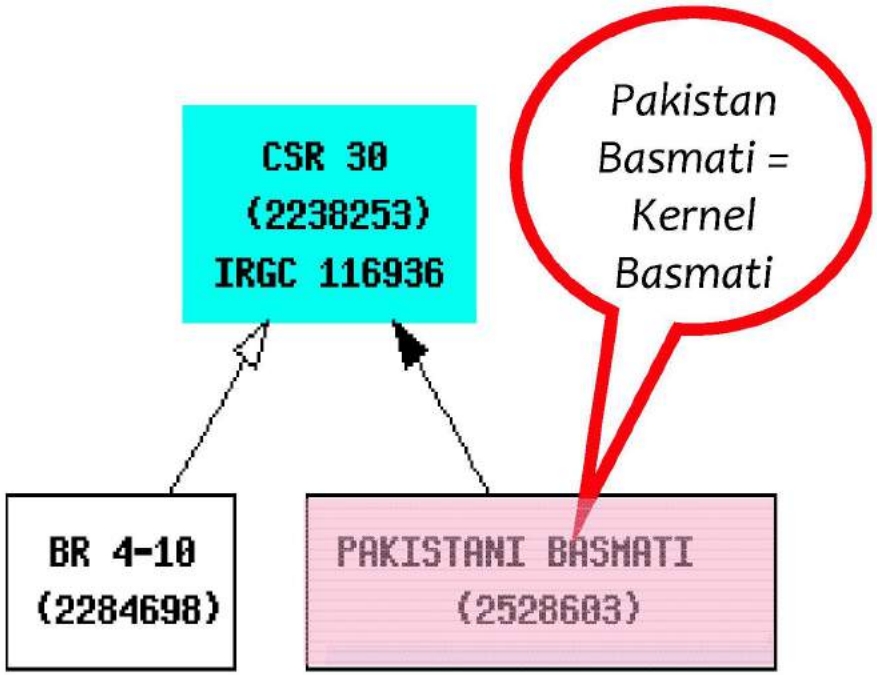
Pusa 1121



- Pusa 1121 is has a basmati grandparent.
- Pusa 1121 has better aroma and lower chalk, which leads to less breakage of grain during milling and better prices than Pusa 1.
- Pusa 1121 occupies about 70% of basmati land in India.
- Pusa 1121 is not on the EU list and does not meet Indian rules for being called basmati.

CSR30/Yamini ≠ Tarori

- CSR30 has a basmati parent – (Tarori Basmati) so meets the Indian basmati rules to be a basmati.
- CSR30 tolerates salty soils and Tarori does not.
- Haryana has problems with salinity.
- Without salt, CSR30 gives double the yield of Tarori, and in saline areas it gives up to 4 times the yield of Tarori.
- Apparently CSR30 enters the mills as CSR30 and leaves as 'pure Tarori'.
- The EU genotyping method does not separate CSR30 from Tarori.



Conclusions

- Neither the current EU specs, nor UPOV parameters authenticate the EU list of basmatis.
- Given the previous talks, it is clear that a set of markers could be developed quite quickly to authenticate each variety.
- If the list is continued, then perhaps tools to authenticate are necessary since it seems likely that the EU could be receiving varieties that are not on the EU list and cannot currently be distinguished.

Is it still politically correct for the EU to subsidise the growth of low-yielding varieties?

- What was the real rationale for listing those varieties? Compensation for lower yield?
- In terms of physical quality, Pusa 1121 and CSR30 are beautiful looking grains.
- In terms of eating quality, perhaps the well trained palates of Pakistanis and Indians could tell them apart, but could the average EU consumer really do that?

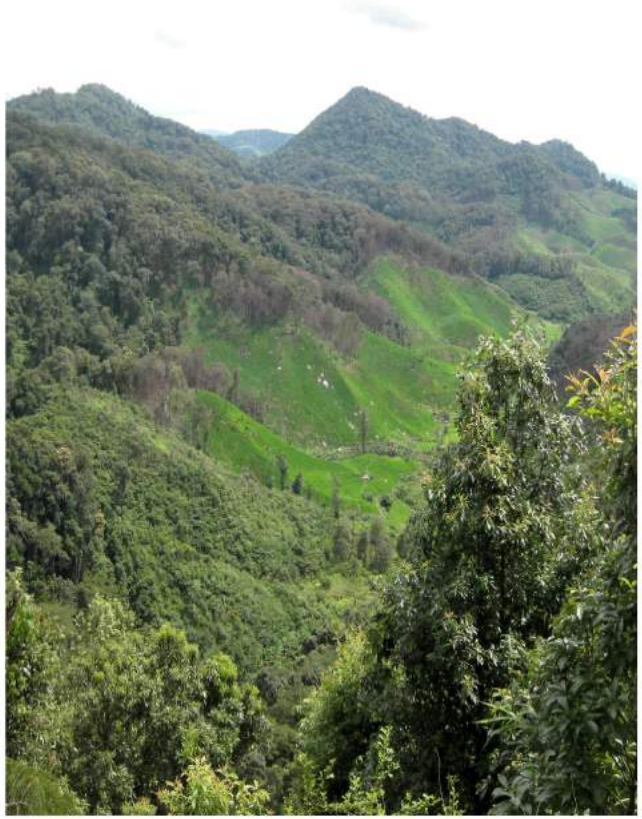
Ethics

- Yields need to increase by 50 kg/ha annually to meet current and future needs for rice – can we afford to grow low-yielding crops?
- Do we have enough land and water to force farmers to grow low-yielding crops?

Rice in the catchment area

Rice on the top of the hill

Grown wherever possible



Capacity of the land to supply

- Lower yield requires more land to be cleared.
- Clearing destroys the forests and the rivers.
- Higher yields per hectare of land save land, save water and feed more people.