the demand for food, fodder, fiber and fuel. Creating new variability is the crux of the varietal improvement exercise. Mutation breeding, wide crosses and such laborious and time-consuming approaches were used to develop genetic stocks and pre-breeding materials. But with the development of transgenic technology it is now possible to move functional genes from one organism to another. Developing a reliable marker-assisted selection (MAS) to transfer the novel gene from the stock to different varietal backgrounds should be our immediate priority. For this, access to advanced instrumentation and chemicals will be required. And only some laboratories have the automated high throughput facilities. This is a very serious limitation for further progress in agricultural biotechnology.

As the per capita income increases and both men and women move to gainful employment, the food consumption pattern and the kitchen need change. So a major part of cereal, fruits and vegetables will go for processing and value addition. The nutritional and other qualities of the material may have to improve to suit processing needs. Since these are polygenic traits difficult to select in early generations, a well-designed molecular approach would complement the several other ongoing efforts.

To move further to specifics that plant biotechnology needs to address, it is felt that irrespective of the crops the following are the various traits that are important: Resistance to insect pests; Resistance to viral diseases and plant pathogen; Tolerance to soil salinity; Tolerance to terminal heat/moisture stress; Upward movement in terms of quality; Enhancing the nutritional value.

Advances made in the development of transgenics in rice (*Bt*), mustard (hybrid) and potato (protein) should be augmented and made fit for commercial usage. While progress has been made in insect pest (Lepidoptera) management through *Bt* gene-based transgenics in cotton and other crops, there are still a lot of opportunities for developing systems to contain other pests. In fact, tomato can be taken as a model system for viral resistance transgenics and has several advantages over other vegetable crops. Though a difficult system, chickpea/pigeonpea/mungbean needs greater attention for biotic stresses due to pod borer, bruchids and nutritional enhancement.

The promoter commonly used in cassette design, the reporter gene, and the genes for the target traits which form the core of the transgenic technology are totally controlled by various multinational patents. This limits the scope of the commercialization of transgenics that have been indigenously developed, as still there are several restrictions on their usage. The task before us is to clone novel tissue/stage/specific/inducible promoters as well as genes of agricultural importance. A number of viral genes have been sequenced and deposited with the international repository. Also the plant virology group has made gene cassette with antisense coat protein gene and the transgenic developed for tomato leaf curl virus is under evaluation. This sort of virus gene mining from simpler systems is necessary so that an Indian replacement for the CaMV35S promoter can be identified.

Despite the claims coming from various Indian laboratories on the transgenics they have developed, the hard truth is that these are far away from commercial usage. A mire of different patents regulates the technology and constructs used in developing these transgenics. Unless it is negotiated with the concerned parties and royalties are paid, the commercial use of these transgenics shall remain a mirage. Even though many public-funded research institutions in India including the IARI have developed different transgenics, they have not examined them from the angle of the various patents that govern their product. The road map to transfer the product developed by them to the seed industry has not been drawn, as the scientists and technocrats have distanced themselves with this reality that is bound to cost the development of biotech business in India. These issues could have been addressed in the special issue.

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# High yield of rainfed cotton through transplanting

With reference to the recent debate about the efficacy of *Bt* gene[1] in improving the yield of cotton, we report a very simple technique to increase the yield of rainfed cotton, without resorting to any genetic manipulation.

Out of about 1.7 million hectares under cotton in Maharashtra state, almost 98% is rainfed. Although the monsoon generally brings rains by about 15 June, farmers delay the sowing of the seed by almost a month, waiting for the soil to be sufficiently wet to ensure good germination. As a result, the seed of rainfed cotton gets sown by about 15 July. The monsoon generally ends by about 15 September, so that a crop that stands in the field for about 6 months, gets water only for the first two months. Because the development of the bolls takes place under drought stress, the yield of such cotton is very low.

It was shown that the yield of cotton could be doubled by planting cotton seed into plastic bags in the month of May and transplanting them into the field in the month of July. In this way, the plants receive water for almost 4 months, instead of just 2. Another advantage of this technology is that the date of planting is advanced by two months, so that the farmer not only gets an early harvest but his crop also escapes the heavy build up

of pests that occurs in the latter part of monsoon. The farmer has only to invest in plastic bags, costing about Rs 60 per ha and the labour of filling the bags and watering them from 15 May to 15 June. Transplanting is labour intensive, but because the number of seedlings to be transplanted per hectare is just 10,000, the labour requirement for transplanting cotton is not very high. In comparison to the directly sown crop, the farmer spends at the most about Rs 500 extra per hectare on the transplanted crop.

Demonstrations were conducted in farmers' fields in Maharashtra, during three consecutive monsoon seasons of 2000, 2001 and 2002. The transplanted plants showed greater height, earlier maturity, more branches, and more and larger bolls than the plants grown from seed directly sown into the field. The average seedcotton yield over all the three seasons and twenty plots was 1513 kg/ha in the transplanted plots as against only 828 kg/ha in the directly sown plots. The transplanted crop thus showed yield superiority of 83% over the directly sown crop.

If this technology becomes popular, farmers having a reliable source of water at their disposal can raise seedlings of cotton for selling them to others. However, seedlings in plastic bags, produced on a commercial scale, cost about paise 40 to 50 per seedling, which is too high a price for the rainfed farmer. In order to reduce the price of seedlings, experiments were conducted under this project to transplant seedlings grown on raised beds instead of in plastic bags. However, cotton plants did not survive if they were uprooted from a nursery bed and transplanted into the field. This finding emphasizes the need for breeding genotypes of cotton, which can tolerate transplanting after being uprooted from a nursery bed.

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# Back to square one with 'Proteoma music'?

Were the authors aiming to become Ig Nobel laureates? A press report from Spain featured something called 'Genoma Music', how 'translated DNA code' makes for 'easy-listening music'. 'Unravel DNA's double helix, picture its components lined up like piano keys and assign a note to each. Run your finger along the keys "for fun" and record an audio version of the blueprint for life.'

'DNA, or *D*eoxyribo*N*ucleic *A*cid, is composed of long strings of nucleotides, the four nitrogen-containing bases: adenine, guanine, thymine and cytosine – A, G, T and C. A snippet of a gene might look like – AGCGTATACGAGT –.Assign tones of the seven-note *Do-Re-Mi…* scale to each letter: Thymine could become *Re*, Guanine *So*, Adenine *La* and Cytosine *Do* and convert the sequence into sheet music.

'Played solo on percussion, classical guitar or other instruments, the sequences sound cute but rudimentary. The alphabet soup of bases served as base lines to accompany melodies. "Genoma music is a way to bring science and music closer together" one of the team, a piano-playing microbiologist who specializes in fungi said. "The mood and rhythm of the underlying genetic code have influenced the melodies. One melody draws on a yeast gene known as SLT2. It features a stretch in which one triplet of nitrogen bases appears several times in rapid succession – a repetitive phenomenon that has a musical equivalent called *Obstinato*…."'

My thoughts took over as I finished paraphrasing the press report. *Time*, the weekly newsmagazine, wrote in its 31 December 1999 Millennium issue: 'Best musical innovation of the [just-about-to die] millennium: About 1040 AD, a music teacher–monk introduced a system of naming pitches to help singers learn new music: *Ut*, *Re*, *Mi*, *Fa*, *Sol*, *La*. *Ut* became *Do* later and *Ti* was tacked on to make the seven-note scale: ***do***, ***re***, ***mi***, ***fa***, ***sol***, ***la***, ***ti***.'

The *Amarakosa* [the 5th century AD, *Roget's Thesaurus* of Sanskrit] says, however:

'***Ni***shaadha***R***shabha-***Ga***andhaara-
***Sh***adja-***Ma***dhyama-***Dh***aivataaha |
***Pa***nchamas-chaityamee ***sapta***
tantree-kanthotthithaah svaraaha ||'

'From which these seven named notes are generated on chords, vocal or taut, ***sa***, ***ri***, ***ga***, ***ma***, ***pa***, ***dh***, ***ni***'. Whence the West's claim of 'musical innovation'? 500 years too late!

One gets to know, even from newspaper clippings on the 50th anniversary of the establishment of the structure of DNA, that 'Genetic code' (*not* 'DNA code') refers to how protein synthesis is controlled by three-letter sequences. Sets of three of A, C, T and G form codons that specify the amino acids needed for protein synthesis and what to do at the 'next stage' [one more amino acid, fold the chain and get it going?].

Amino acids essential to life are twenty-two in number, they say. 'Genoma music' composers would not have stopped at merely assigning arbitrary tones of the seven-note chromatic scale to the four bases had they been aware of certain technical aspects of Indian classical music. Venkatamakhin, the 17th century author of the *Chaturdandi Prakaashikaa* ('The Illuminator of the Four Disciplines'), and his immediate successors, set down the *Melakarta raaga chakra*, a 'Periodic Table' of generative (*janaka*) *raagas*. Claiming 'all melodies, by whomsoever and wherever played, can be derived from these primary *raagas*,' the *Prakaashikaa* quotes *really* ancient Sanskrit treatises: (Wo)man was earlier able to distinguish twenty two *swaras* (notes) between the octaves. That ability was lost, present day wo(man) can distinguish only twelve *swaras* on which to build the structures of the derived melodies (the *janya raagas*). These melodies have the freedom to move their defining notes within certain ranges, allowing their *lakshanas* (flavours) to be