Bt-COTTON IN INDIA

Brainstorming
Over
Whatsapp

Whatsapp group:
Crop Improvement

Group admin:

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SUMMARY

This report is a summary of deliberations over the whatsapp group “Crop Improvement” over a period of 23 days between 20 Jan 2023 – 12 Feb 2023. The scope of this summary covers only the discussion related to Bt-cotton, as also the research publications discussed in this regard. The participants in the debate included highly experienced experts from plant breeding, molecular genetics, cell biology, agronomy, entomology, agronomy, agro-economics, farming, agri-entrepreneurship and research management. Brief background and credentials of the participants in the debate are stated towards the end of this report. The take home message from the deliberations is summarised as below.

1. Agricultural demands
   All participating group members agreed on the burgeoning population and the need to step-up agricultural productivity drastically. Further, GM technologies and genome editing are too powerful not to be deployed and need to be taken onboard. There was unanimity on these observations.

2. Cotton productivity
   Cotton productivity in India has improved in the post-Bt-cotton era compared to the pre-Bt-cotton era, while overall pesticide use has come down. There was unanimity in the house on these observations. However, the debate on whether the gains are modest or huge, was inconclusive.

3. Pesticide use
   The efficacy of Bt-cotton, since 2002, in controlling the target insect pests i.e. lepidopteran pests, was endorsed by all participating group members. However, the breakdown of resistance to target insects and the emergence of new insect pests, like the sucking pests, was also acknowledged. Overall, there was unanimity that the net application of chemical pesticides has been brought down due to Bt-cotton usage.

4. Factors contributing to the enhanced cotton productivity
   The major factors contributing to the enhanced cotton productivity are Bt-cotton, the use of hybrids and intensive input farming. However, the relative contribution of these factors remains debatable.

5. Refugia
   There was an agreement that the use of refugia in Bt-cotton is a strong and proven approach in managing the insect pests. It was also pointed out that the farmers tried to avoid refugia, since it was perceived to bring down overall yield. To check the discard of refugia seeds by farmers, the RIB (Refugia-in-Bag) strategy was appreciated by all. However, the late introduction of RIB policy enhanced the breakdown of resistance to insects targeted by Bt transgenes. A suggestion was made that F2 Bt seeds could be used as refugia.

6. Comparison of GM crops and pharmaceutical drugs
   A comparison was made between the regulation of GM crops and that of pharmaceutical drugs and antibiotics. It was argued that many pharmaceutical drugs, antibiotics and vaccines are products of genetic engineering. Likewise GM crops should not be viewed with undue suspicion. On the flip side, it was opined that these are two entirely different issues and should be treated separately – firstly, because unlike drugs, vaccines and antibiotics, pollen from GM crops once let loose becomes a permanent part of the

ecosystem and secondly because of level of urgency – prescriptions drugs are a human health necessity, while GM crops are not.

7. Transgene escape to wild germplasm

Likelihood of transgene escape to wild germplasm was discussed. Pollen viability and outcrossing was discussed. Evidence, in the form of published literature, for horizontal and vertical transgene escape to intraspecific wild germplasm, interspecific germplasm and intergeneric hybrids, was presented.

8. Biosafety of Bt-cotton

The biosafety of Bt-cotton was highlighted. No group member reported or pointed to any adverse effects of Bt-cotton on human or animal health.

9. GMO regulation and stake holders

It was proposed that consumers of GM products should be given a distinct voice in the GMO regulatory apparatus. It was further stated that farmers, scientists, crop breeders and industry have financial and professional stakes involved in GMO releases, hence they should not be considered as unbiased consumers. The house was divided on this issue. As counter-argument, it was stated that farmers themselves account for 60% of the consumers, as also, all members of the regulatory agency are consumers themselves.

10. High-density planting system (HDPS)

The adoption of Bt cotton in India has been implemented by way of Bt hybrids, replacing most of the local desi cotton OPVs, inbreds and landraces. This situation contrasts with many nations like Australia, Brazil, USA, China, Turkey etc., wherein high-density planting system (HDPS) using Bt Open pollinated varieties (OPVs) is followed. The net productivity of HDPS-based Bt-cotton is significantly higher than Bt hybrids.

Introduction of HDPS-based Bt-cotton in India was discussed. Prominent remarks on this issue were:

a. HDPS would imply the need for ideotype breeding and synchronised maturity for mechanical harvesting.
b. Small size of Indian farms would not be suited for HDPS in Bt-cotton.
c. Since HDPS using OPVs would allow the farmers to produce their own seeds for the next sowing, this would bring down the costs in purchase of Bt hybrids for each growing season.
d. We require a stronger IPR system for HDPS to be successful here.
e. In case desi cotton varieties show better adaptability and abiotic/abiotic resistances to localised climates, HDPS could be a good option. It was stated that Bt cotton hybrids have proven to be more adaptable in certain areas. Neither of the OPVs or hybrids might be a magic bullet. A review of the status quo was suggested.
f. HDPS does not necessarily mean OPVs have to be used. Hybrids could be designed for higher density planting, intermediate between the exiting planting density and HDPS.

11. The role of Public sector R&D in India

The release of Bt-cotton in India has brought into open the loopholes in public sector R&D initiatives in India. Even in two decades since the launch of Bt-cotton by Monsanto, we have not been able to come-up with a single viable GM-cotton option against the insect pests. Not just that, natural cotton germplasm was not screened enough to identify and incorporate natural biotic resistances into elite cotton.

Given the deep pockets of international seed companies, the Indigenous seed companies stand at a disadvantage to conduct comparable R&D to come up with matching GM options. This makes it all the more important for public sector R&D in India to be proactive and efficient in deploying GMO research and recombination breeding using natural cotton germplasm to develop agronomically needed cotton varieties.

Nevertheless, the entry of Bt-cotton in India by Monsanto was a welcome development that led to farmer prosperity and enhancement in agricultural productivity. Many group members were quick to underline that international organizations should be appreciated and encouraged to bring in newer solutions for the mitigation of agricultural problems.

12. Benefit-drag and compensation to farmers

Farmers are at the receiving end of the agriculture chain. Even though they produce food, the major share of the benefits goes to professionals involved in downstream processing and sales of food and food-based commodities. This was stated as a reason to be generous to the farmers in regulating Bt-cotton if it supports farmer profits. In the same context, another reasoning was that we should not mix-up issues by compensating one for another. GMO regulatory process involves multiple stake holders, of which farmers are just one. At the same time, we need to work on empowering the farmer by default in the agricultural chain, like supporting the farmer producer organizations (FPOs) so that farmers reap the benefits of the entire supply chain from farm to fork.

13. International cotton research centre

While there are international research institutions, like IRRI for rice, ICRISAT for millets and pulses, CIMMYT for wheat and maize, there is none for cotton, even though cotton is an internationally important crop. This limits access to global cotton germplasm and collaborative research initiatives.

14. Political interference

It was emphasised that the decisions on GM releases should be taken based on technical recommendations, with immunity to political interference. All participating group members agreed.

15. Credibility of GMO regulatory apparatus – the uncomfortable questions

Questions were raised on the credibility of regulatory apparatus – does it take into account all the stakeholders? Who are all the stakeholders in GMO regulation? An argument was made that since pharmaceuticals are approved and accepted without much concern, GMOs should also be accepted likewise. However, as a counter-argument, it was submitted that pharmaceuticals and GM crops are totally separate issues and should be treated as such.

Rajeev Taggar
02 Feb 2023

WHATSAPP MESSAGES TEXT

S No.	Name/Date/Time	Remarks
1	Group admin 22/01/23, 15:31	Dear all, This is to extend a very warm welcome to join the whatsapp group "Crop Improvement" created by Saikap Biotech! The group is meant to share thoughts, ideas and information on improving crop productivity. The invitees may please choose not to avail of this invite, if this does not suit you. Personal space is respected. So this will not be an offence. All the members are requested kindly to adhere to the following group rules and guidelines. 1. The group will include people from diverse areas of crop improvement, like plant breeding & genetics, cell biology, tissue culture, NGS technologies, agronomy, plant pathology, seed technology, plant sciences, plant biotechnology and bioinformatics. The focus of the group will be "Crop Improvement". 2. The participants come from a background of diverse nationalities, cultures, faiths and political affiliations. To keep the group meaningful, harmonious and focused, kindly avoid these issues not related to the group theme. 3. Greetings are to be avoided since it is easy to choke the group with seasonal and regional greetings. 4. The group will have restricted membership. Only genuine participants, who relate to the group theme and also can be trusted for a good behaviour should be recommended for group membership. 5. Contact numbers of the group members are strictly not to be shared with anybody else without prior and clear consent. 6. The group will not be a platform for self-glorification. A publication or an award is a glory in itself. Declaration of publications by the worthy group members at this platform will be appreciated only if the publication is open-access type so that all group members get the worth of their time investment. More will be added to the above as suggested by the group members or as time demands. Let us celebrate and enjoy our subject, as also update ourselves continuously with latest developments in our field! Welcome all of you once again!! Best regards, Group admin

2	Hari Sharma 25/01/23, 14:40	Dear All, I had been having a cursory look at the discussion that had been going on over the past couple days. It's important that we take note of the following facts to Ratan informed decision on GM crops. Lot of noise was made about Bt cotton. But >95% of the area today is under Bt cotton hybrids. Why? Because the farmers harvest more yield, and today the total cotton production is over 375 lakh bales compared to 110 lakh bales in the 1980s. The insecticide sprays are down to 5-7 compared to 25 - 35 in 1980s. Outbreaks of jassids , whiteflies and pink bollworm are due to absence of sprays for Helicoverpa. There are no adverse effects of Bt cotton (See over 25 publications by my group at ICRISAT), including 2 books on biotechnology and the bio safety. There are no adversely effects of Bt on animals other than Lepidoptera insects, as all Bt proteins are broken to sminotacids at a pH of 1.5 - 2.5, as there are no receptors to bind to Bt proteins in higher animals. Similarly, we should test the efficacy of male sterility system in Brassica, as the natural cmd gives us less than 10% heterosis. The GM sterility systcan previous an opportunity to develop high yielding hybrids to reduce our dependence on imports, currently over 1.7 lakh crores. Most of the antibiotics, enzymes, and several drug ingredients are derived through GM microorganisms. All we all use them without raising an eyebrow. This is a harsh truth, as I served in RCGM in DBT. We should have commercialised Bt Brinjal, Golden rice and many othe GM crops with novel traits to reduce the use of highly toxic pesticides, which are neurotoxins. LD 50 value of Bt is 5000 mg/kg body weight as compared to 0.1 mg of Aldicarb, Carbofuran, Acetamid and many other pesticides. Hence, let's be rational. All scientific decisions should be taken by the scientists based on facts, not by politicians or lawyers, who do not have an idea of Gene- protein - and biological properties of the end product. For more information, you may read: Application of biotechnology in Pest management….., and Bioisafety of Biotechnology and conventional IPM technologies…., by Sharma, HC.
3	Rajeev Taggar 25/01/23, 14:53 Re: Hari Sharma	Many thanks indeed Dr Sharma for enlightening us with your thoughts and experience. It might take many of us some time to digest it all and come up with opinions and more information. But your effort is heartily appreciated.

	25/01/23, 14:40	As I stated before, Dr HC Sharma is the former Vice Chancellor of YS Parmar University of Agriculture & Forestry, Solan, Himachal Pradesh. He is a most distinguished entomologist, having been the President of International Entomologiest Association and IRS Scientist at ICRISAT for an extended period of time. I did not know Dr Sharma has also been the member of RCGM, which is mandated to take regulatory decisions for India. These words would indeed be a powerful statement at any national and international forum. So, let those genuinely interested in finding solutions to GM issues may kindly chip-in with their thoughts, please!
4	Rajeev Taggar 25/01/23, 14:56	Dr Sharma, while your statement is so robust that it leaves little for any more remarks, let us face the harsh reality - doubts do exist. Forwarding herewith some concerns expressed by none other than the Director of Central Institute of Cotton Research (CICR), Dr Kranthi. I am trying to get Dr Karanthi on-board at this forum. Regards
5	Rajeev Taggar 25/01/23, 14:57	DOC-20230122-WA0001. (file attached) kranthi_stone_2020_nature_plants_0 (1).pdf
6	Sachin Kulkarni 25/01/23, 15:09 Re: Hari Sharma 25/01/23, 14:40	Thanks 🙏 I agree with majority of your comment Sir except one were I have a doubt you a comment saying *outbreaks of jassids and white flies are due to absence of sprays for Helicoverpa* On the contrary majority of pears in the pesticide industry thinks that contact pesticides especially synthetic parathyroid use to control helicoverpa Kills natural Enemies (beneficial insect) of sucking pest like jassids and whitefly ultimately leading to their outbreak. You view on this pl🙏 👍 Rajeev Taggar
7	Rajeev Taggar 25/01/23, 15:24 Re: Hari Sharma 25/01/23, 14:40	The group has already reached a conclusion on the issue of male sterility using the Barnase-barstar system. The house gave it a thumbs up. So, we do not seem to have any disagreements here. We all agree with you as you stated, at least those of us who are joining the debate. An outstanding remark was made by Mr Nilasis Ghosh, who has been a committed mustard breeder for many decades - that the barnase-barstar system is likely to find even more use in rice, in years to come. The suggestion was acknowledged and appreciated.
8	Raghavendra Sandhikar 25/01/23, 15:28	Perhaps, we can cap the discussion on the male sterility/barnase-barstar issue, unless any more solid points emerge, and move on with the GM-cotton issue. A perfect summary of facts. Thank you very much sir. As you rightly said the number of sprays have certainly gone down but along with it the population of parasites and predators should have gone up has

		not happened. Your statement about toxicity of pesticides vs that of GM crops is very valid. Thanks for sharing your thoughts. 🙏
9	Suren Tikoo 25/01/23, 15:31	My only addition to the discussion after profusely thanking Dr Sharma for his excellent summary. No solution is for life. Research should have continued to find solutions that will keep emerging. By capping GM research has hurt us. Will get into more of that a bit later .
10	Ravichandran V 25/01/23, 15:44 Re: Sachin Kulkarni 25/01/23, 15:09	I was growing Non Bt OPV & Non Bt Hybrids for about 18 years before I awitched over Bt Cotton. Those days I used to spray multiple chemicals and other biological inputs including Bt Spray formulations. None of these chemicals controlled Boll Worms. Rather the boll worms developed resistance against these chemicals. However these chemicals rather killed non target organisms including some of the sucking pests and all the predtors like lady bird beetles, spiders etc. Now I refrain from spraying any insecticide to control bollworms as they are taken care of by the Bt Protein in all parts of the plants. If you visit any of the Bt Cotton fields in our region you will see more number of predators than before. Sucking pests seem to be dominant in Bt Cotton today because, our main concern was Boll Worms earlier which is practically absent in our Bt Cotton fields. The sucking pests are the only pests we need to control now. My understanding is these sucking pests neutralized by the multiple predators that are spared in Bt Cotton fields. I am sure, if you make a formal comparitive study about sucking pest in Bt Cotton and non Bt cotton, its population would be relatively lower in Bt Cotton field due to the presence of insect predators. I use sticky color traps and careful use of light traps to control sucking pests. As the seeds are treated with imidacloprid no sucking pest menace in the first 5-6 weeks.Rarely I spray insecticides to control sucking pests. Ravichandran Farmer
11	Rajeev Taggar 25/01/23, 15:49 Re: Hari Sharma 25/01/23, 14:40	Dr Sharma, I would beg to differ when you compare antibiotics, enzymes and drugs with GM-crops. GM-crops once released can never be retracted back - the pollen is out forever, while the pharmaceutical products are one-time release: they do not reproduce and stay in the environment forever. Secondly, pharmaceuticals are a health necessity, even if a little risk is involved, GM-crops are not.
12	Vinod Patel 25/01/23, 15:51	Dear Group members Can any expert guide about RRF (Roundup Ready Flex) Cotton ?? Is this any additional benefits to Indian farmers?? Is there any environment problem?? Vinod Patel

13	Rajeev Taggar 25/01/23, 15:56	Introducing to the group: Mr Vinod Patel. Mr Vinod Patel is a highly focused, devoted and capable cotton breeder, with decades of experience in cotton breeding. I can vouch that he eats, drinks, sleeps and dreams cotton!! Thanks for joining us all here Vinod. We do look forward to learning a lot from you on cotton (at least). Regards, Rajeev
14	Rajeev Taggar 25/01/23, 17:16	The topic raised by Dr HC Sharma is likely to take few days before we summarise! 🙏
15	Rajeev Taggar 25/01/23, 17:21	Anybody desirous of summarising may let us know here please. If not, I shall. 🙏
16	Hari Sharma 25/01/23, 20:10 Re: Rajeev Taggar 25/01/23, 14:57	Any intervention in the ecosystem has its consequences. For every action, there is a reaction, be it improved varieties, use of agrochemicals or changes in cropping system. But, the ecological processes then lead to a state of homeostasis or ecological equilibrium. If we want to increase productivity per unit of area/ unit of time , then some issues will crop up for which we need to find solutions. Research is a continuous process, it's not static, Dr Kranti has expressed opinions from an ardent proponent to what is expressed in this paper. Cheers and stay safe!!!
17	Hari Sharma 25/01/23, 20:13 Re: Sachin Kulkarni 25/01/23, 15:09	Both are true. Use of contact pesticides kills the natural enemies, but reduction in sprays fro 25 to 5 - 7 is also one of the reasons. The pesticide industry will certainly emphasize their point of view.
18	Hari Sharma 25/01/23, 20:16 Re: Rajeev Taggar 25/01/23, 15:49	The GM crops will survive in natuoif they produce seed. But decision to deregulate a GM crop is taken only after studying its bio safety in the environment.
19	Hari Sharma 25/01/23, 20:20 Re: 25/01/23, 15:51 - Vinod Patel	Whether we use Roundup on non transgenic crops or on GM crops, its consequences are same in the environment. Use of Roundup on GM crops provides an effective control of weeds in the standing crop, which is a boon to the farmers. All soybean, maize, mustard and many other crops grown in Americas are herbicide resistant. And they are using them for over 2 decades.
20	Suren Tikoo 25/01/23, 20:23	My response was also based on sane logic. Research has to continue and find solutions. Problems never cease to occur. Reasoning things

	Re: Hari Sharma 25/01/23, 20:10	out is the need and not unnecessary fears. We need to believe the regulatory system. If there are weaknesses there those need to be overcome. Science under duress will lead us no where
21	PJ Kulkarni 25/01/23, 20:47 Re: Suren Tikoo 25/01/23, 20:23	True Sir. I would like to share few points i am convinced about. 1) We have shifted from 2G to 5G mobile connecvity and there are many other examples where we moved to advanced technologies in life. We also know pros and cons of each one, but still majority of us accept the change willingly or unwillingly. 2) Name any single technology in the world which is 100% full proof, safe and completely environment friendly. 3) We as Agricultural Research Scientists ultimately- directly or indirectly- aim to improve the productivity, quality and production of an assigned crop. 4) Right from conventional breeding methods upto new biotic tools till CRISPR - are available at our disposal and we have to make a choice looking at the golden mean and farmers' needs to reduce production cost or increase productivity.
22	Rajeev Taggar 25/01/23, 22:10	Dear all, It gives me great pleasure to welcome to the group, Mr Ram Kaundinya, the Director General of the Federation of Seed Industry of India (FSII) !! An alumnus of the prestigeous Indian Institute of Management (IIM), Ahmadabad, Mr Kaundinya has served in too many senior most positions for me to count or know of. But prominently, he has been the Managing Director of Advanta and has been a scientific advisor to the Prime Minister of India for a long stretch of time. Personally, what captured my recognition of him as an industry stalwart was his incisive articles, his humility in dealings and his sharp understanding and reporting of complex issues facing Indian agriculture in general and the seed industry in particular. We do look forward to sharing our thoughts and information with you, Sir, as also learning from your experience and wisdom. With Best regards, Group admin
23	Rajeev Taggar 26/01/23, 06:36	Reference 2: kranthi_stone_2020_nature_plants_0 (1).pdf Forwarding the same paper just to let Mr Kaundinya know what we are discussing

24	Rajeev Taggar 26/01/23, 06:53	One of my concerns is that in all of the discussion we have had so far, and at most fora, while farmers benefits are considered supreme, consumers are never considered a stake holder! Should we not account for every bit of foreign DNA that is added to a crop, which is useful for growing the crop but does not add any value to the crop outcome for the consumers? True, the bar gene helps kill the herbicides or helps in the initial stage of screening the transgenics, but do the consumers gain anything out of it? For that matter, does even the barnase-barstar complex add any value to the crop for the consumer? No. Let us not forget that the whole of genome now stands proven to act as a single system! Every gene affects every other gene. Also, the biosafety testing can only be a limited exercise, not even close to being all inclusive. So, why should the consumers accept that crop with a tinkered DNA? Consumers should be discussed as at least an equal stake holder while we discuss farmers profits. I am not anti-GM but let us be fair to all the stake holders, not just the farmers and the environment.
25	Ravichandran V 26/01/23, 09:00 Re: Rajeev Taggar 26/01/23, 06:53	Sir, Let me share my thoughts from the farmers perspective. Nodoubt farmers stand to benefit from the intervention of the technology including GM Crop as yield increases and cost reduces. However we the farmers are incidentally the biggest consumers of agri commodities. For instance I grow, rice, cotton,moong, urad and sugarcane. These are not the only farm commodities I am consuming. The major portion of my diet comprises of farm commodities produced else where. The vice versa is also true ie a farmer in other regions may not grow the crop I am growing.Nearly 60% of our population still depends on farming. As a farmer I can't afford organic wheat/mustard/sesamee/Dhuvar/vegetables etc which are sold at a high premium. Though I am not against Organic farming, and I DO use lot of organic inputs, I have a question. If organic farming yield more and cost less , why should they be sold at a price not affordable by the consumers. I am really happy that few of my farmer colleagues make big profits by selling the organic products in the niche market. Certainly aam aadmi like me especially farmers CAN'T afford the luxury of Organic food. I support GM Crops which are formally approved, because the yields are more, costs less and sold at affordable price.
26	PJ Kulkarni 26/01/23, 09:05 Re: Rajeev Taggar 26/01/23, 06:53	Dr Rajeev, Yes, consumer is also an important stakeholder in agricultural commodity chain. However, to achieve a sufficient amount of production- productivity is critical. The basic equation applicable is Yield =GxExM G- Genotype E- Environment M-Management

Environment is beyond our control, hence, other two factors "G" and "M" we can influence to ensure the productivity,
May it be in the form of yield or quality or any value added character.

Now, we are left with two major ways to ensure desired level of productivity by a) agronomic intervention b) Improving genetic yield potential of cultivars.

Agronomic interventions may create a variable impact and recommondations may not be followed by the farmers uniformly. Moreover, soil and moisture availability, rainfall patterns will influence impact of agronomic interventions.
Ultimately, the most viable option available is to make genetic improvement for targeted trait/s.

Earlier genetic improvement was solely by conventional methods - selection, then using intra-specific as well as inter-specific hybridization, mutation, and many other breeding methods.
Then, transgenics made possible to get targeted genotypes in a short span with significant impact which conventional methods couldn't do.

Now, using intra specific hybridization or transgenic method you insert 'foreign ' DNA or gene.
Please note that the current crop species evolution happened thru natural hybridization and selection involving many species, in which alien gene got inserted naturally.

For transgenics, if there are queries related to Biosafety - then a revised and robust policy should be implemented considering all possible perceived threats to environment and all the living beings which might get affected.

Take an example of pulses production in India has reached a platue and no break though is likely seen further. Population is increasing and on the other hand the
land source is limited.

If like GM Mustard, Hybrid Production Tech in pulses is developed along with tolerance to key biotic stresses like pod borers , then productivity will increase, farmers will definitely benefit, consumers

will get the required quality, at an affordable cost.
If needed, due to optimum productionand due to increased productivity-the area can shift to another potential crop cultivation.

Conclusively, I would favor transgenics/GM crops provided all the needful studies are done thoroughly.
Coming to environmental hazards, no negative impact on Environment seen due to Bt technology even after 21 years.

		Cotton with Herbicide tolerant traits helping positively in USA, Brazil, Australia, South Africa to farmers and no negative impact on the end consumer. Same is the case with Bt Brinjal in Bangladesh. Therefore, as a neutral approach, I would support any method that can help every stakeholders and meets the requirements without any serious problems to nature and all dorms of living beings.
27	Ram Kaundinya 26/01/23, 10:12 Re: Rajeev Taggar 25/01/23, 22:10	Thank you Rajeev for admitting me to the group. Just one correction: I was never an adviser to PM. I was a member of a committee formed by Principal Scientifc Advisor to PM which functioned under the Chairmanship of Dr RS Paroda and submitted a report of policies and actions required for a secure and sustainable agriculture in India (2019). I was also a member of Dr Swaminsthan Task Force that drafted the Agri Biotech Policy (2002-2004). I spent 22 years in pesticide industry, my last assignment being MD of Cyanamid Agro. In seed industry since 2001. Was Global CEO of Advanta for 8 years. I was the Chair of ABLE- AG which was involved with Policy Advocacy work for Agri Biotechnology in India. Currently DG of Federation of Seed Industry of India. I am happy to be here.
28	Sharad Deshpande 26/01/23, 10:26	🙏🙏 We are honoured to have you amidst us. Welcome Sir. Sharad Deshpande
29	Suren Tikoo 26/01/23, 10:40	Honoured to have you in the group 🙏 You are the best person to address the question Rajeev raised on impact on consumer. I firmly believe that there is no impact on consumer. The risk is as much as an unpredictable accident on the road. So should we stop driving. Strong regulation and then believing the recommendations of an appointed scientific body is the only way forward.
30	Ram Kaundinya 26/01/23, 10:41 Re: Rajeev Taggar 26/01/23, 06:53	This is a specious argument. Agriculture is a production system. If the efficiency of the production system is improved using modern technology it will increase productivity & quality and reduce cost - these benefits will flow directly to consumers through increased availability reduced prices and better quality of food. In case of output traits the consumer gets benefited but normally there is a yield drag for the farmer. Success of such technology depends on identity preserved supply chain system that rewards the

		farmer adequately and consumer gets food with specific quality enhancement (usually at higher prices). But the bottom of the pyramid still needs large volume of food at affordable prices. Use of modern technology to increase yields and reduce costs is very important for this vast majority of Indian population. The only assurance consumer needs is that the food he is consuming is safe irrespective of how it is produced. Who has to give him such assurance? Who gives us the assurance that the vaccines we are taking and the rDNNA tech based medicines we take every day are safe for us? Don't we depend on the Regulator's approval as the confirmation of safety? The same holds good for GM or Gene Editing technology. If we don't trust our regulator whom do we trust? How do you get 140cr consumers approval for a technology? You can debate with the regulatory whether they can improve the process. But let us note that they also follow Internationally accepted protocols without which our products will not be allowed to be traded Internationally. It is a much more complicated subject than just asking a few thousands of consumers whether they accept food produced using a particular technology 26/01/2023, 10:42 - Suren Tikoo 👌👍 26/01/2023, 11:00 - Sharad Deshpande 🙏🙏👍 26/01/2023, 11:52 - Sachin Kulkarni 👍👍
31	Rajeev Taggar 26/01/23, 11:54 Re: Ravichandran V 26/01/23, 09:00	Mr Ravichandran, this is not exactly the point here Sir. Of course, farmers are also the consumers. But they also have a financial interest in GM regulation. So, they cannot be equal stake holders as the consumers/general public who do not stand to gain any profit out GM crops, apart from the actual value of the crop produce.
32	Rajeev Taggar 26/01/23, 12:09 Re: PJ Kulkarni 26/01/23, 09:05	Yes Dr Kulkarni, I also agree with your reasoning that consumers benefit indirectly when the productivity goes up. However, as i have expressed above in response to statement by Mr Ravichandran, giving the farmers over-riding say in GM regulation would not be justified. We need GM approval members from pure consumer public who do not have a financial stake involved.

		We are now talking about a very important issue here: Should the farmer be always viewed with pity or we should attempt to make agriculture a profitable venture and the farmer a businessman? Agriculture is the major occupation in India and a major occupation across the globe. We need a model of agriculture that sustains itself and is profitable. Unwittingly, we are getting drawn to a bigger debate - Farmer producer organizations (FPOs) let the farmers work as cooperatives, manage agriculture from farm to fork, minimise middlemen and earn a major share of revenue emerging from agriculture. So there are ways of empowering the farmer other than assigning undue powers and credit. Does that mean we should train our farmers to turn into business - yes, that is what it means.
33	Suren Tikoo 26/01/23, 12:10	A GM crop based on say better nutritional quality would be for consumers but only if science is allowed to work on those aspects. Philippines has allowed Golden Rice and we can't say that their authorities hate their citizens & hence the approval. In my opinion what has happened in crop improvement space in last five decades is 1. Conventional Breeding, 2. Mutation & Disease resistance breeding, 3. Molecular breeding and Genetic engineering and currently the more complex nutritional quality & abiotic stress using modern tools is taking largest space. Gene editing is the culmination of this part of research and is nothing but mutation by design. This progression is the direct result of steady increase in knowledge and not because one was preferred method over the others. It is clear that the realization that the attention soil amelioration required is also putting attention of researchers to address that. The huge move towards use of biologicals is a step in that direction. In a decade or so the current debate would have died down and replaced with new conflicts. Important to have the conflicts as that moves us towards continued problem solving. 👍 Nilasis Ghoshdastidar
34	Rajeev Taggar 26/01/23, 12:11 Re: Ram Kaundinya 26/01/23, 10:12	Thanks for the correction Mr Kaundinya, Sir, as also my apologies for my ignorance regarding some important milestones in your illustrious career. We are so happy to see you here.
35	Rajeev Taggar 26/01/23, 12:16 Re: Suren Tikoo 26/01/23, 10:40	I agree with you Sir when it come to the GM regulation. My point was about giving the consumer due voice in GM regulation, distinct and separate from the farmers. As the two of us have been discussing before, I am broadly in favour of Bt-cotton. Bt-cotton was a success story. Some details are coming out, which mighy be worth discussing here. Also, GM-mustard

		(Barnase-barstar/male sterility system) stands endorsed by the worthy group members here, including myself.
36	Suren Tikoo 26/01/23, 12:20	Thanks. We are then on same page. Each and every member of any regulatory body is a consumer first. Do we can't really say consumers are not represented.
37	Rajeev Taggar 26/01/23, 12:55 Re: Ram Kaundinya 26/01/23, 10:41	My 2 cents herewith Sir: 1. Agree with you that the fate/profit-loss of consumers and the farmers is tied up. 2. Yield drag - agree that the farmer is at the receiving end of the agriculture chain. That is why i believe that we lack an efficient system of agriculture chain. Perhaps we need to work on empowering the farmer by default in the agricultural chain (like FPOs) rather than mixing up issues and trying to compensate one for another (eg. GM crops just to make the farmer better beneficiary). 3. Allow me to say Sir: I think pharmaceuticals and GM crops are totally different issues and each of them deserves a unique addressal: If we compare antibiotics, enzymes and drugs with GM-crops. GM-crops once released can never be retracted back - the pollen is out forever, while the pharmaceutical products are one-time release: they do not reproduce and stay in the environment forever. Secondly, pharmaceuticals are a health necessity, even if a little risk is involved, GM-crops are not. 4. On the point regarding burgeoning population and the need to step up productivity drastically - I agree with you. GM technologies and genome editing are too powerful not to be deployed and have to be taken onboard. No two opinions here. 5. Totally support the conclusions you have made - we need to take all stake holders together, while also ensuring that we make the best use of modern technologies of genetic manipulation to feed our teeming millions and to enhance the food quality, as in pulses and millets.
38	Rajeev Taggar 26/01/23, 12:57 Re: Suren Tikoo 26/01/23, 12:10	Well said Tikoo Sir, we sure need to move ahead with the times. No two opinions on that.
39	Ram Kaundinya 26/01/23, 20:49	Rajeev The question is not about agri vs pharma. It is about the credibility of a regulatory body. If we accept the that rDNA products cleared by GEAC are acceptable but GM crops approved by the same body are not acceptable then there is some thing wrong with that logic. Activists strategy is to cast aspersions on regulators so that public loses confidence in them. My limited point is that we should trust our regulators. You can engage with regulators in a constructive dialogue in order to improve

		the processes. But once a regulators has cleared something don't put it to public scrutiny or court scrutiny- both of them don't have capabilities to assess technologies. You have a regulator or you don't have a regulator. You cannot be half pregnant!
40	Vinod Patel 26/01/23, 20:59	Absolutely right about regulatory...we have proud about our regulatory system.
41	Rajeev Taggar 26/01/23, 21:08	Listening Sir. Agree that our approach should be to refine the regulatory system rather than run it down.
42	Nagendra S 26/01/23, 21:0 Re: Rajeev Taggar 26/01/23, 12:55	Rajeev ji, I have the argument that GM once released can't be taken back. But it is not a valid argument. Old varieties are withdrawn and new ones are promoted all the time. Farmers have stopped growing less productive old varieties by themselves and these are preserved only in the gene banks with great organisational effort else they will become totally extinct. Thus a GM variety can be recalled by simply not producing the seed and advising farmers not to grow it. Seeds loose viability and DNA is quickly degraded and can be preserved and perpetuated with great effort, it will not propagate itself or even persist without effort unlike autotrophic microorganisms, or abnoxious weeds like pathenium and lantana.
43	Suren Tikoo 26/01/23, 21:09 Re: Ram Kaundinya 26/01/23, 20:49	Exactly right
44	Rajeev Taggar 26/01/23, 21:16	Dr Nagendra Singh, Sir, On the flip side there are pollen grains that survived for millions of years. So, it would be difficult to say that the GM pollen will degrade or even loose viability. We have a cryopreservation expert in our group, Prof Uma Rani, who could perhaps let us know how long the viable pollens can be stored. But quite likely, the storage and viability period is likely to be quite long.
45	Nagendra S 26/01/23, 21:25 Re: Rajeev Taggar 26/01/23, 21:16	Pollen grain may survived for long time but they are viable. They loose viability very fast. We breeders know it when trying cross hybridisation, only fresh pollen at particular time of today gives seed set. We may isolate DNA from mummies or naturally preserved material but an organism cannot rise from the dead. There are no examples of that at least I don't know one.

46	Rajeev Taggar 26/01/23, 21:30 Re: Nagendra S 26/01/23, 21:25	Reference: 7 https://www.sci.news/biology/article00194.html
47	Rajeev Taggar 26/01/23, 21:31 Re: Nagendra S 26/01/23, 21:25	Here is the results of a quick google search Sir. Herein, somatic plant tissue was revived after 32,000 years. Pollen is even more hardy. 26/01/2023, 21:33 - नागेन्द्र सिंह Nagendra S Assoc Pb: I have already mentioned that you have to make great effort preserve them in viable form. They will not survive naturally and rise from the soil or water and pollinate and contaminate new varieties. We produce pure seeds of varieties any way. Horizontal transfer does happen but it is least probable event, more deleterious events are generated by spontaneous mutations. In fact quite often the genes used in transgenic are already taken from nature, other organisms living in nature.
48	Nagendra S 26/01/23, 21:34	But it has to be revived it did not rise from the dead on its own.
49	Rajeev Taggar 26/01/23, 21:36	You are also right Sir. This is a grey area.
50	Nagendra S 26/01/23, 21:44	See, the most abnoxious organisms, most potent poisons and allergens are all present in the nature, they have not been created by GM crops, these are not biological warfares like some naturally pathogenic microorganisms which are designed purposefully to make them more potent to cause harm. GM crops are regulated right from conceptualisation up to environmental release.
51	Rajeev Taggar 26/01/23, 21:48	Agree Sir. However, as scientists, we need to be critical also. Glossing over the flaws may not be the right approach. By the way, I have a prediction (Pardon my immodesty, Sirs 🙏): If we check for Bt genes and all other transgenes in wild crop relatives of the commercially released crops, we shall find that the trangenes have already spilled over to crop wild relatives. In fact, I wanted to do this work myself in my lab. I wanted to assign this project to students from university in and around Chandigarh/Mohali. Unfortunately, Covid lockdown was harsh on my business and i had to shut down my labs. I paid space rentals for onr and a half year without making any profit. All equipment was sold off. 😢

		But no regrets. It was a venture worth it. Just waiting for some other labs to pick up this work and publish.
52	Ravichandran V 26/01/23, 22:44	Well said. We trust regulators. Let decisions on GMOs be made for their scientfic merits. Once the regulators approve/disapprove a GMO let us abide by their decision.
53	Nagendra S 26/01/23, 22:44	Horizontal gene transfer is a reality. There is lot of work on horizontal gene transfer between species but it's frequency is very low and gene frequency will remain low unless some selection pressure is applied. My argument is that is this doing any significant harm ? Are there good examples of that. You take soil samples from any where Bt bacteria can be isolated from it, our institute and others have done it, because that is where Bt gene came from to start with. These are complex questions and more work needs to be done to study the dynamics of it.
54	Rajeev Taggar 26/01/23, 22:48	No Sir, not necessarily horizontal gene transfer, quite likely even by vertical gene transfer the transgenes are likely to be transferred to related crop species, I guess.
55	Manoj Phalak 26/01/23, 22:49	Except barbadense the transgenic cotton that is hirsutum has not voluntarily donated Bt genes to any cotton species. People have tried to intrograce in arboreum but failed.
56	Rajeev Taggar 26/01/23, 22:53	Oh, has the transgene transfer to barbedense been proven? Shall appreciate if you could send me a link please. Thanks
57	Manoj Phalak 26/01/23, 22:54	Sir BG II HB Hybrids are there in Market
58	Rajeev Taggar 26/01/23, 22:54	Reference: 3 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5033179/ Got this publication. The work has been done already
59	Rajeev Taggar 26/01/23, 22:56	Ok, thanks for correcting my ignorance Dr Phalak.
60	Manoj Phalak 26/01/23, 22:56	fear of unknown is the most difficult thing to explain. They look or rather pretend to be scientific but has very little substance.
61	Manoj Phalak 26/01/23, 22:57	Analysis Paralysis should be avoided in greater interest to humanity.
62	Rajeev Taggar 26/01/23, 22:57	Agree
63	Nagendra S 26/01/23, 22:59	This is the job of the regulator to ensure Biosafety. There are elaborate SOPs for this. I trust their honesty. If there are some black

	Re: Rajeev Taggar 26/01/23, 21:48	sheeps in the system they should be appropriately dealt with. My argument was on the point of recalling a harmful GM that has slipped through the regulatory check. I have argued that it can be recalled or discontinued, except for rare horizontal gene transfer to related species where it will remain in low frequency unless selected for. Genes with acute toxicity are taken for GM crop development. There are checks and balances at each stage.
64	Rajeev Taggar 26/01/23, 22:59 Re: Manoj Phalak 26/01/23, 22:57	Let us avoid motherhood statements here please, Dr Phalak.
65	Manoj Phalak 26/01/23, 23:01	This is not motherhood statement, you are discussing about 30 year old technology, which has made great impact in farmers livelihood. I can understand about new concept for discussion.
66	Rajeev Taggar 26/01/23, 23:01	We need to remain objective and specific please.
67	Rajeev Taggar 26/01/23, 23:02 Re: Manoj Phalak 26/01/23, 23:01	The debate is alive, sir. Very much so.
68	Manoj Phalak 26/01/23, 23:04	Keep it alive but try to convince farmers not to cultivate any transgenic material, they are better judge ..
69	Ravichandran V 27/01/23, 05:56 Re: Manoj Phalak 26/01/23, 23:04	Yes. If a technology works well we whole heartedly accept and adopt it. If it doesn't we have no hesitation in showing the exit gate. Inspite of agressive and fictitious allegations we the cotton farmers have been sowing Bt Cotton for about 2 decades, because it improves yield and reduces cost.
70	Rajeev Taggar 27/01/23, 06:09 Re: Ravichandran V 27/01/23, 05:56	Your statement will be included in the summary with the respect it deserves Sir.
71	Chandrashekhar Chaporkar 27/01/23, 06:56	Ravichandran ji, Technology has been effectively working for over 26 years globally as has been illustrated on several platforms.Unfortunately, together we failed to reap benefits of the advancements made in science.Complacency to some extent could be the reason….

72	Nilasis Ghoshdastidar 27/01/23, 07:45	The present scenario can be compared against the erstwhile cotton growing scenes. Farmers used to spray at least a dozen times, sometimes with spurious chemicals in vain. The govt used to arrange for aerial sprays over wide areas! Unfortunately the videos are not available to rekindle the memory. It may be assumed that quite a few people have lost lucrative business aftet the arrival of Bt in cotton! However, the way it came to the market via a non-entity company called as Navbharat seeds was not laudable!☺ Nagendra S 👍 Ravichandran V 👍
73	Rajeev Taggar 27/01/23, 14:22	At last! Vaccines officially annulled. Court lost! Share ! LATEST NEWS !!..... but bad news for those who are already vaccinated.... After today's ruling no longer needed, UNIVERSAL VACCINATION ABOLISHED! The US Supreme Court has struck down universal vaccination in a great victory for freedom ! American infectious disease 'specialists' Bill Gates, Antoni Fauci and Big Pharma have lost a case in the US Supreme Court by failing to prove that all their vaccines over the past 32 years were safe for the health of citizens! The lawsuit was filed by a group of scientists led by Senator Robert F. Kennedy Jr. who declared: 'The new Covid vaccine must be avoided at all costs!!!!!!!! He urgently drew your attention to important issues concerning the upcoming Covid-19 vaccination: for the first time in the history of vaccination, the so-called next-generation mRNA vaccines directly interfere with the patient's genetic material and thus alter the individual's genetic material, i.e. genetic manipulation, which was already prohibited in the past and was previously considered a crime. 1945 Nuremberg Treaty. The COVID Sars 2 vaccine is not a traditional vaccine. What was always a vaccine? It was always the pathogen, the microbe or the virus itself that was weakened, thus rendered harmless, and introduced into the body to produce antibodies. It is part of the new mRNA (Messenger Ribonucleic Acid) group. Once the mRNA is inside a human cell, it reprograms the cell's RNA and the cell's RNA reprograms the cell's normal DNA to start producing another protein. In other words, it is not like traditional vaccines because it is a genetic manipulation tool! As a result of the unprecedented mRNA vaccination, vaccinated persons will no longer be able to continue treating the vaccine symptoms. Vaccinated persons will have to accept the consequences because they will no longer be able to be cured by simply removing the toxins from the human body, just like a person with a genetic defect such as Down syndrome, Klinefelter syndrome, Turner syndrome, heart failure genetics, haemophilia, fibrosis, Rett syndrome, etc.), because the genetic defect is eternal! This clearly means: if a vaccination symptom develops after mRNA vaccination, no therapist will be able

		to help, because the damage caused by this type of vaccination will be genetically irreversible. https://1scandal.com/etats-unis-la-cour-supreme-annule.../> <https://1scandal.com/etats-unis-la-cour-supreme-annule.../> BRAVO ROBERT KENNEDY JR. !!!! BIG NEWS UNITED STATES SUPREME COURT OVERRULES UNIVERSAL VACCINATION So all the countries of the world, civil organisations and all of us fighting against this DEADLY VACCINE now have REAL science to confirm how harmful this so-called deadly vaccine is. Just like the vaccines they have been using for the past 33 years where they could not prove their effectiveness. This DEATH VACCINE violates the GENETIC MANIPULATION PROHIBITION OF THE NORIMBERRA TREATY OF 1945, according to which these contained mRNA that alters human DNA and are now TRANSHUMAN *
74	Rajeev Taggar 27/01/23, 14:24	Finally the American supreme court declares!! The dangers of not understanding enough - for those who presented Covid vaccines as an example how we can take shorts to regulating genetic manipulations.
75	Rajeev Taggar 27/01/23, 14:25	We shall be summarising the debate in a couple of days. So, any more info and ideas are welcome. Admin guarantees due respect to all the honest comments made herein!! We are all friends with the good of society in heart, so nothing will be/should be taken personally at this forum. 🙏
76	Sachin Kulkarni 27/01/23, 14:50	Is this a credible news source ?? *1scandal.com* 😳 Reference: 6 https://www.reuters.com/article/factcheck-supreme-court-cancel-universal-idUSL1N3331YA
77	Rajeev Taggar 27/01/23, 15:33	Thanks Sachin ji. I stand corrected.
78	Rajeev Taggar 27/01/23, 15:38	Apologies to all for this unchecked forward.
79	Suren Tikoo 27/01/23, 15:41	Rajeev, WhatsApp University has very deep roots. 😩
80	OP Dhankhar 27/01/23, 18:18 Re: Rajeev Taggar 27/01/23, 14:22	Absolutely not a creditable source and there are so many unchecked posts on COVID vaccine online from anti-vacciners. There is nothing wrong in MRNA vaccine and it's a breakthrough advancement in biotechnology based vaccines which will be used in

		future for other deadly diseases. The records are very clear that vaccine saved millions of lives. We will appreciate the admin to check the facts before using Whatsapp as a megaphone!!!
81	Rajeev Taggar 27/01/23, 18:20	Ok boss. Thanks for your feedback. Points taken!
82	OP Dhankhar 27/01/23, 18:22	Moreover Robert Kennedy Jr. Is not a scientist or doctor who under this incredible science. He is using this as his political agenda same way as Trump did. But hypocrisy as Trump was the 1st one in America to get the vaccine in Dec 2020 before the vaccine becomes available to public!
83	Rajeev Taggar 27/01/23, 18:28	You know what - I took the first shot of the Covid vaccine on your recommendation!!
84	OP Dhankhar 27/01/23, 18:35	Thanks Rajeev! That's why we are discussing otherwise without vaccination who knows where we would have been!!!! Look at China now what situation they are going thru because the Sinovac was not effective vaccine and in India the Covishield is not an mRNA vaccine. It's a regular vaccine with weakened SARS-Cov-2- spike glycoprotein vaccine.
85	Rajeev Taggar 29/01/23, 02:43	Dear all, It is clear from the comments of various group members, which includes experienced crop breeders, academic plant breeding & genetics experts, a renowned entomologist and a highly experienced farmer, that Bt-cotton has been a game changer in Indian agriculture and the Bt genes have been extremely effective in controlling some insect pests. However, before we summarise, I would like to present in nutshell the publication by Kranthi & Stone, 2020, which is quite an exhaustive study on Bt-cotton in India, as also a mention of some other noteworthy implications of Bt-cotton. This will be followed up first by any counter remarks by the worthy group members and then by the overall summary of our debate on Bt-cotton. Kranthi & Stone, 2020 1. The yield advantage in Bt-cotton was due to two factors: a) large scale replacement of cotton OP varieties by hybrids and b) insect resistance imparted by Bt genes. 2. In addition to the inherent yield advantage by cotton hybrids, Bt-hybrids led to intensive agriculture in terms of fertilizers, irrigation and the expensive purchase of hybrid seeds. 3. Locally adapted desi cotton varieties have been largely replaced by American upland cotton.

4. There was an initial and drastic drop in insecticidal sprays of Bt-cotton for few years. American bollworm (ABW) was effectively checked (2002-2009). However, 2009 onwards pink bollworm (PBW) began to show up and became a serious issue soon enough, which continues till date. Concurrently, the attacks by sucking insects also became a major problem.
5. According to Kranthi & Stone, 2020, as things stand, taking into account the above factors, the gains from Bt-cotton are modest.

Other points of relevance to Bt-cotton

1. Hybrids or OPVs Cotton yield in India is far lower than many of the nations like Australia, Brazil, USA, China & Turkey. A very likely reason for this is the use of high-density planting system (HDPS) in these nations i.e they plant many more cotton plants per hectare than we do. Further, they use cotton OP

2. varieties and not hybrids. OP varieties are amenable to HDPS, not the hybrids. Farmers don't need to purchase the expensive hybrid seeds season after season. Plus they get higher yield. HDPS has been touted to be the future of cotton production in India (Dr BM Khadi).
3. In case we have to shift to OPVs from hybrids, we shall need to re-prioritise our breeding objectives – like moving from bushy type to erect ideotype. Also, IPR system will have to be improved, otherwise the seed companies will be reluctant to put their technologies, like Bt genes, into the OP varieties. Have we been on the wrong roadmap so far – using Bt hybrids?
4. Replacement of Indian desi cotton varieties by upland cotton hybrids, which are not so adapted to local environment, has meant making our cotton crops susceptible to a range of insect pests and other biotic/abiotic susceptibilities. Is it worth sacrificing the advantages of locally adapted desi cotton varieties for upland cotton hybrids just because they carry the Bt genes?
5. Is GM-cotton, sustainable for India – bearing in mind the fact that we shall be constantly dependent on the foreign MNCs for providing us newer and newer Bt or other transgenes or stacks of transgenes? Why have we not been able to catch up with the transgenics research, discover and patent novel resistance genes and produce our own commercial transgenic crops? Have we done enough to make use of our germplasm to screen and introgress resistances into our adapted elite lines, as and when time demands?

While Bt-genes themselves have proven their mettle, incorporating these genes into commercial cotton varieties remains an issue. The

		above points would be useful to evaluate the role of Bt-cotton in the past couple of decades in India, as also in designing our future cotton research programmes. Hopefully, after the current round of debate we can close-up and summarise. 29/01/2023, 02:43 - Rajeev Taggar: <Media omitted> Reference: 2 kranthi_stone_2020_nature_plants_0 (1).pdf
86	Dharmendra Daukia 29/01/23, 07:00	OPVs may have high value in some pockets. More Comparative trials needed. Wider genepool preservation needed Intensive genetic research efforts on cotton need to be undertaken ASAP in India and continued for very long time(till cotton exists on earth). One of the most important crop in FoodShelterCloth basic needs bracket. Strategically important for India Some Q need to be examined (if not already). 1. Before BT, Indian farmers were also on OPVs. Do we have trial results of HDP of that Era. 2. Are the yields in A B U C T countries following OPVs higher than BT cotton in India. If yes, then is it more cost beneficial to growers. If yes, thete is case for BT rejection. 3. This paper has data till 2010 on most of fert and Yield aspects Recent data on same and seen with profitability numbers will helo better decision making. 4. Gujarat had a few colored cotton varieties. Are they still grown. Could that be a USP for better price realization and could research be done that would be develop more and wider colorful varieties ? Natural Colored Cotton (without dyes and checmicals) could help transform cotton industry. Do such proposals have merit: Technically and financially. 5. BT research: What are the factors which restricted the matter for so long time with big, good scientific pool existing in India
87	Rajeev Taggar 29/01/23, 08:49	Thanks Good one Mr Daukia. Let the debate continue ..but I suggest let us restrict to Bt cotton please. Slithering off to areas like coloured cotton will make the topic hard to handle and conclude.
88	Dharmendra Daukia 29/01/23, 08:54	Thank you

		Well that is fair if the objective is BT:YES OR NO and How to improve BT But if the objective is about Improving Cotton in general along with farmers income one may have another thread for that.
89	Rajeev Taggar 29/01/23, 08:58	Ok, at a later stage. We have had detailed discussion already before you joined. Now is the summarising and conclusion stage. Thanks
90	PJ Kulkarni 29/01/23, 09:12 Re: Rajeev Taggar 29/01/23, 02:43	Dr Rajeev, Excellent summarization. There are few facts on which also need to look in to. 1. From 2009 it started with SURAJ Bt variety and then many got released till recently. Need to introspect why 96% farmers still grow BGII hybrids in normal spacing and even in HDPS or closer planting density? Need to review why varieties not accepted on a larger scale? 2. Pink bollworm resistance development:- structured refuge was not being grown around BT cotton by >95% farmers and one of the reseaons which led to pink bollworm resurgence. Then, we landed up having RIB very late after many rounds of discussion and debates. 3. Hybrids and Heterosis: India invented Hybrid technology in cotton and it is a proven fact that F1 Hybrids are not only superior in yield than varieties but have better, wider adaptability and adjust to environmental fluctuations. 4. I don't agree that dependency on MNCs on GM technology is any issue. The best technologies available for farmers in the world, need based they should be available to Indian farmers after needful studies. The major issue is even after 21 years of Bt in commercialization, why not any Indian Lab haven't come with a equally good or better transgenic tech? 5) For accessing diverse germplasm in crops there are International Research Institutions like for Rice there is IRRI, Millet and Pulses - ICRISAT, Wheat and Maize -CIMMYT. For cotton ?? Also, since 10 years ICAR is still formulating policy to share germpalsm. Every year it is being discussed only. 6. Why can't we adopt a US/BRAZIL/ AUSTRALIA pattern of Research- where in Universities do basic research and development new germplasm and hand over to private industry to create commercial products.

		In nutshell, strong policy is to be formulated to decide on genetic improvement, agronomy (state and region wise) to work on target of 1000 kg Lint/ ha in India from currently dwindling between 460 to 500. Private sector and Govt institutions need to work hand in hand with equal respect for each other.
91	Rajeev Taggar 29/01/23, 09:23 Re: PJ Kulkarni 29/01/23, 09:12	Point 4: Dependency on MNCs. Because once we start depending on MNCs they decide the costs. They have deep pockets, their R&D is hard to match so they can keep adding new genes forever and dictate the prices at will. If we can decentralize this locally by developing our own technologies, reducing or eliminate dependence on hybrids and use our locally adapted elite germplasm, we stand to gain lot more. When natural resistances are used, home-grown technologies are available and farmer can produce his own seeds for the next sowing, this checks intensive input, helps the farmers, preserves local germplasm, at the same time adding to farmer profits. Points 5&6 are spot-on. Agree The idea is not to put any kind of stigma on MNCs.
92	Suren Tikoo 29/01/23, 09:27 Re: Rajeev Taggar 29/01/23, 02:43	Hi Rajeev, Thanks for the summary but please don't mind my saying this. I think you seem to be sitting on two horses unable to decide which one to chose. My point by point replies to your summary on Dr Kranti's paper- Have used all capitals in my answers to each point for easier reading. "Kranthi & Stone, 2020 1.The yield advantage in Bt-cotton was due to two factors: a) large scale replacement of cotton OP varieties by hybrids and b) insect resistance imparted by Bt genes. - YES 2.In addition to the inherent yield advantage by cotton hybrids, Bt-hybrids led to intensive agriculture in terms of fertilizers, irrigation and the expensive purchase of hybrid seeds. YES. 3.Locally adapted desi cotton varieties have been largely replaced by American upland cotton. Desi cotton definitely has better resilience but cotton fiber is mainly usable for medicinal gauzes, cotton etc as it is not lengthy enough to make finer fabric. MY QUESTION - WHAT PREVENTED RESEARCHERS TO IMPROVE ITS FIBER QUALITY AND/OR TRANSFER ITS BIOTIC/ABIOTIC RESUSTANCE TRAITS TO G.hirsutum. 4.There was an initial and drastic drop in insecticidal sprays of Bt-cotton for few years. American bollworm (ABW) was effectively checked (2002-2009). However, 2009 onwards pink bollworm (PBW) began to show up and became a serious issue soon enough, which continues till date. Concurrently, the attacks by sucking insects also

became a major problem. NOT ENTIRELY TRUE. WHY DID RESEARCHERS THINK THAT NOW THAT WE HAVE A BIG BULLET ANY MORE ISSUES WONT COME UP FOR EVER. AS SOON AS BG1 WAS RELEASED IT SHOULD HAVE TRIGGERED RESEARCH INTO FINDING a. NEW EVENTS , b. PREEMPT ISSUES LIKE EMERGENCE OF SUCKING PESTS AND VE READY WITH PLAN B, c. ON PEST MANAGEMENT STRATEGY COME UP WITH A HOLISTIC PLAN TO CONTROL SUCKING PESTS - a plan by SABC (Dr Mayee & Dr Bhagirath doing a great job on this). d. IMPROVE SUCKING PEST RESISTANCE IN HYBRIDS. EVEN IN HIRSUTUM GERMPLASM EXCELLENT SUCKING PEST RESISTANCE EXISTS BUT RECOMBINATION BREEDING INVESTMENT TO COMBINE THIS WITH BEST HIRSUTUM LINES WAS MIISSING & lastly e. A DELAYED DECISION TO MOVE THE EXTRA REFUGIA PACKETS INTO A RIB (Refugia seeds mixed in bag as is now in place - quite late an action in my opinion.

5.According to Kranthi & Stone, 2020, as things stand, taking into account the above factors, the gains from Bt-cotton are modest. THIS IS A PREPOSTEROUS CONCLUSION THAT EVEN DR KRANTI NAY NOT LIKE. MY ONE SENTENCE REPLY- PLEASE DONT't UNDERESTIMATE OUR FARMERS INTELLIGENCE. 99% ACREAGE UNDER HYBRIDS DIDNT HAPPEN BECAUSE OF LOVE OF JUST SCIENCE BUT REAL GAINS IN GROUND BY FARMERS.

Other points of relevance to Bt-cotton

1.Hybrids or OPVs

Cotton yield in India is far lower than many of the nations like Australia, Brazil, USA, China & Turkey. A very likely reason for this is the use of high-density planting system (HDPS) in these nations i.e they plant many more cotton plants per hectare than we do. Further, they use cotton OP varieties and not hybrids. OP varieties are amenable to HDPS, not the hybrids. Farmers don't need to purchase the expensive hybrid seeds season after season. Plus they get higher yield. HDPS has been touted to be the future of cotton production in India (Dr BM Khadi). HDPS CERTAINLY IS THE RIGHT APPROACH BUT HAS ALSO COME THROUGH A LOT OF BREEDING WORK TO DEVELOP HDPS SUITABLE GENOTYPES COMBINED WITH DEVELOPMENT AND RELEASE OF DEFOLIATORS AS WELL AS MECHANICAL HARVESTORS THAT MADE ONCE OVER HARVESTING POSSIBLE. ADMITTEDLY SUCH GENOTYPES THOUGH AVAILABLE HAVENT BEEN
WORKED ON DUE FEARS OF IP BY PRIVATE SECTOR. THOUGH PUBLIC SECTOR HAS COME UP WITH SUCH GENOTYPES - I have seen in Akola few years back- THEY HAVENT BEEN ADAPTED BECAUSE THEY DONT MATCH ADAPTABILITY OF BEST HYBRIDS IN MARKET YET AND THE INFRASTRUCTURE TO GO FOR MACHINE HARVEST HASNT MATURED. THE DEFOLIATOR FROM BAYER (WORKS BEAUTIFULLY AS WAS DEMONSTRATED BY US AT TIERRA IN A SHORT COLLABORATIVE EXPERIMENT WITH THEM) IS STILL PENDING REGISTRATION APPROVAL BY AUTHORITIES. EVEN IF THAT HAPPENS THE SMALLER AREA PER FARMER DOESN'T LEND ITSEKF TO USE OF THE LARGER

MECHANICAL HARVESTERS OF USA ETC. WE NEED FARM AUTOMATION FOR THE SMALL FARMERS.
2.In case we have to shift to OPVs from hybrids, we shall need to re-prioritise our breeding objectives – like moving from bushy type to erect ideotype. Also, IPR system will have to be improved, otherwise the seed companies will be reluctant to put their technologies, like Bt genes, into the OP varieties. Have we been on the wrong roadmap so far – using Bt hybrids? YES THAT RESEARCH NEEDS TO BE CARRIED OUT. ALSO SINCE HETEROSIS FOR YIELD IS PROVEN IN COTTON WHY SHOULDN'T WE ALSO WORK ON HAVING HYBRIDS THAT ARE AMENABLE FOR HDPS. MAY BE WE DINT NEED 6 PACKETS PER ACRE BUT JUST 3 To GET US THE BENEFITS OF HETEROSIS AND NOT WORRY ABOUT IP ETC. WE CANNOT JUST GO FOR JUST INE STRATEGY WITHOUT TESTING ALTERNATIVES SBD THEN COMING TO A SCIENTIFIC CONCLUSION
3.Replacement of Indian desi cotton varieties by upland cotton hybrids, which are not so adapted to local environment, has meant making our cotton crops susceptible to a range of insect pests and other biotic/abiotic susceptibilities. Is it worth sacrificing the advantages of locally adapted desi cotton varieties for upland cotton hybrids just because they carry the Bt genes? WRONG CONCLUSION. AS SAID ALREADY THE WORK ON RECOMBINATION BETWEEN THE NATIVE AND EXOTIC COTTON GERMPLASM HASN'T BEEN DONE TO AN EXTEBT THAT US NEEDED. DR KHADI's COMMITTEE HAS RECOMMENDED INTERSPECIFIC HYBRIDIZATION RESEARCH TO AAICRP ON COTTON.
4.Is GM-cotton, sustainable for India – bearing in mind the fact that we shall be constantly dependent on the foreign MNCs for providing us newer and newer Bt or other transgenes or stacks of transgenes? Why have we not been able to catch up with the transgenics research, discover and patent novel resistance genes and produce our own commercial transgenic crops? Have we done enough to make use of our germplasm to screen and introgress resistances into our adapted elite lines, as and when time demands? NO NEED TO CURSE MNC's. THEY HAVE INVESTED MILLIONS TO REACH A USABLE TECHNOLOGY. THE QUESTION IS ALTERNATIVE EVENTS NEED TO BE DISCOVERED. I CAN't ANSWER WHY THEY HAVENT BEEN DISCOVERED. IS IT COMPLACENCY OR KAVK OF RESOURCES. FOR ME IT IS AN OOOPORTUNITY LOST TO CREATE AN EXCELLENT PPP PROJECT.

While Bt-genes themselves have proven their mettle, incorporating these genes into commercial cotton varieties remains an issue. The above points would be useful to evaluate the role of Bt-cotton in the past couple of decades in India, as also in designing our future cotton research programmes. WHY DO YOU THINK IT IS AN ISSUE?

Hopefully, after the current round of debate we can close-up and summarise."
Hope to hear answers

93	Sharad Deshpande 29/01/23, 09:29 Re: Suren Tikoo 29/01/23, 09:27	Yes Rajeev did a wonderful sum up.👍 I was lucky to be anchor of a webinar by Dr Khadi Sir on ATPBR platform. It was about HDPS Cotton. Dr Khadi presented hard data to prove that OPVs with synchronised maturity and suitable for machine harvest features were the real need of the day! This means we were chasing a wrong target with huge investment into F1 cotton research and much more complex seed production? Are the Indian landraces of cotton capable of taking this challenge in terms of yield and fiber quality? I remember a feeble attempt by UAS Dharwad of introducing a varietal cotton named "Abhadita", with tall claims of various resistances. Sadly, it was given decent burial after two planting seasons.
94	PJ Kulkarni 29/01/23, 09:38	Good morning Everyone. Let me introduce myself. I am Dr Pandurang Kulkarni, Lead Breeder (Cotton) currently with SeedWorks International Pvt Ltd from 2021. Enjoying Cotton Breeding Research since 2001 till date. Had an opportunity to work in TMC project on long staple arboreums and then on Bt, BGII and next transgenic technologies for hybrid development in India and Africa. Looking forward for healthy, constructive discussion and learning from Seniors. Thank you.
95	Sharad Deshpande 29/01/23, 09:44	No Senior or Junior here!😄🙏 Some of us are Seniors by age! Let us share, exchange, debate and if necessary fight with our bits of knowledge and experiences. BTW Dr Pandurang, welcome to this Group. Look forward to gain more knowledge from you.👍
96	Ravichandran V 29/01/23, 10:04	Good morning everyone. I wish to join the discussion and share my experience on OPV , Non Bt Hybrid and Bt Hybrid. Way back in 2023-2024 I was apprehensive about Bt Cotton as I was carried away by false reports in media. I decided to have a hands on experience by sowing OPV, BT Hybid and its non Bt counterpart in one acre each side by side. I made a thorough analysis of cost -beneifit. I found Bt Hybrids outperformed the Non Bt Hybrid. Non Bt Hybrid outperformed OPV. Only after getting thoroughly convinced about the performance of Bt Cotton, I started growing Bt cotton in a larger area.

Based on my over 35 years of cotton experience, I wish to reply all the concerns expressed by Dr Kranthi.

I am taking each of his concerns and replying them seperately.
Here I go.

Kranthi & Stone, 2020

1.The yield advantage in Bt-cotton was due to two factors: a) large scale replacement of cotton OP varieties by hybrids and b) insect resistance imparted by Bt genes.

Reply: Three factors impact yield. Yield potential of the variety.

Biotic and Abiotic Stress factors significantly influence yield.
These are
a) Pest, disease and weeds
and
b) Drought, flooding, salinity etc.
We the farmers adopt various techniques to address these stress factors and try to increase yield.
Yield of cotton depends on the number of flowers, squares and bolls that set in the plant. The primary cause and most worrisome cause prior to the introduction of Bt Cotton was, boll shedding due to boll worms. Those days farmers like me tried different techniques both chemical and non chemical interventions including applying Bt Spray formulations. None of them were effective in controlling boll shedding due to boll worms. Ever since the introduction of Bt Cotton, the boll shedding due to boll worm was practically nil. In other words, boll retention rate of Bt Cotton was much higher than it's non Bt Counter part, which ultimately translated into higher yield.
However there are other factors like weed, disease, drought, flood and salinity factors, adversely influencing the yield. Fortunately Genitic Engineering could offer viable solutions to address these problems. Unfortunately for our nation and more specifically for our farmers, research work on GMOs are vetoed for reasons other than for their scientific merits. Every crop have their potential yield. We seldom achieve the potential yield in the farmers field due to biotic and abiotic stress factors. In a single crop viz cotton and with a single trait viz pest (boll worm resitance) we are able to achieve higher yield in cotton. Through Genetic Modifications, if we have disease resistant and weedicide resistant, drought, flood and salinity tolerant varieties, we will be able to achieve near about the potential yield. The yield would enhance significantly.
It is something like an automobile giving maximum mileage under ideal road conditions.
For better performance the plant should enjoy unhindered vigour right from the day it sprouts. From my 37 years of farming experience, I have seen when there are hindrance at the growth phase it would get reflected on yield. In cotton after 15 days of sowing, spotted bollworms would affect the tender shoot portion

		restricing its growth. The spotted bollworms damage the tissue from inside and the shoots would wither and droop. Retriving the crop is a great challenge. In Bt Cotton such damages don't take place and the cotton crop enjoys unhindered vigour right from the day it sprouts. Hybrids and OPVs : I have been sowing hybrids since 1993. It is an undeniable fact that, Hybrid, be it cotton or rice, yield more than OPVs. Though the highbrid rice yielded more, I gaveup sowing hybrid rice because the grains are longer and head rice recovery is less. The market don't prefer hybrid rice inour area for the aforementioned reasons. We started using Non Bt Hybrid from 1995, due to its higher yield. There were less number of cotton hybrids those days. Inspite of that we were impressed by its yield potential. Hybrid cotton, whether Bt or Non Bt; the fiber characteristics were same. The textile industry never had an issue procuring hybrids from us. I am not averse to OPV Cotton. There are few good OPV Cotton. If Bt OPV Cotton varieties are made available, we will have the option of sowing that too. I will share my experience on Kranthi sir's other concerns.
97	Sachin Kulkarni 29/01/23, 10:24	I agree👍 one important point I would like to mention is getting highest yield potential out of any hybrid is not possible without proper *integrated balance nutrition and irrigation management* Maintaining proper soil moisture especially at critical growth phases like boll formation and development is the key drip irrigationwith balance fertigation can make dramatic diffrence in yield
98	Ravichandran V 29/01/23, 10:35	Dr Kranthi. 2. In addition to the inherent yield advantage by cotton hybrids, Bt-hybrids led to intensive agriculture in terms of fertilizers, irrigation and the expensive purchase of hybrid seeds. My reply: The fertilizer dosage depends whether it is sown in rain fed conditions or irrigated conditions. For Hybrids (Bt or Non Bt) the NPK dosage applied in irrigated cotton is 120:60:60 and rainfed 80:40:40 respectively. For OPV the NPK Dosage is 80:40:40 and 60:30:30 respectively for irrigated and rainfed condotion. In Irrigated condition the spacing of Hybrid is 3'x3' . Total number of Hybrid (both Bt hybrid and non Bt Hybrid) per acre is 43560/9 = 4840 plants. For OPV, in one acre we maintain a spacing of 2'x1'. ie number plants per acre is 43560÷(2x1) = 21825 plants. To sow 4840 hybrid cotton, we spend 10 laborers and pay Rs 250/labour. That is cost of sowig hybrid is Rs 2500. To sow 21825 of OPV the farmer has to spend nearly Rs 11270.

		Besides he has to nurture more opv plants in one acre. While applying fertilizer in split doses, we don't scatter the fertilizer like we do in paddy field. We place the fertilizer at the root zone. We call this packet manuring. Though the fertilizer cost of Hybrid is nearly 50 % more, the fertilizer placement cost is much higher in OPV cotton than Hybrid ie over 4 times the labour cost that we spend on hybrids. We must work out the different elements of cost , material, labour and over head. We must look at the differential cost of sowing and fertilizer application cost of Hybrid and OPVs. Coming to the pricing of Bt Cotton seed, for one acre 3 kg of OPV Seed would be needed. It costs Rs 690 (ie Rs 230/ kg of unlinted seed) For Bt Hybrid 2 packets of seed would be needed . It costs Rs 1600/ acre. We must see the relative advantage of sowing Bt Hybrid over OPV. We must see the extra beneifit derived by paying the higher seed cost per acre (1600-690=Rs 910).
99	Rajeev Taggar 29/01/23, 10:46 Re: Suren Tikoo 29/01/23, 09:27	Good morning Dr Tikoo, I am nobody, Sir. What matters is the specifics and the nuts&bolts of the issue, the big picture - both at the level of personal perceptions and shared perception, fall in place as a natural consequence. I neither claim nor want to be immune to assimilation of new information and ideas, so would like to grow with the debate rather than emerge the same as i was before the debate, even if it means riding multiple horses, not just one or two. 3. Moot point for further debate - should we incorporate known and genetically-mapped resistances to locally adapted germplasm or transfer all the adaptability to hirsutum just to get its few resistances? I believe it would make more sense to keep local germplasm as the background material and the commercialized resistances as the donor. 4. I never meant that the magic bullet should not be used. Rather we need to add more of such bullets, as you are already indicated in the excellent work being done by Dr Bhagirath and Dr CD Mayee at SABC. 5. Quoting the exact text from the conclusion section of Kranthi & Stone, 2020, Sir: "However, we find that the technology’s benefits have been modest and largely ephemeral. Bt adoption has been conspicuously incongruous with positive yield effects. Changes in other inputs, including irrigation, insecticides and especially fertilizer use, cor respond better to yield rises. Moreover, Bt seeds’ positive effects on

		spraying were fleeting. Countrywide yields have not improved in 13 years, and Indian cotton farmers today are spending more per hectare on insecticide than they did before Bt began to spread." This is preposterous, Sir: ...underestimate the intelligence of our farmers. In fact, I have given top priority to the comments from the farmers. The comments of Mr Ravichandran were not only prominently highlighted, these are being incorporated visibly in the develpoment and recording of this debate. Not only that, the advantages and benefits of the Bt genes have been stated in clear and unambiguous terms. Other points of relevance 1. Hybrids or OPVs Well stated ....HDPS in India is a work in progress! Will take some time ...private players like yourself could be the game changers with major positive effect on cotton farming in India. 3. Replacement of Indian desi cotton varieties ...we are on the same page. Nothing different from this was stated. The questions were an answer in themselves. 4. No I dont curse the MNCs - I am pointing to the failure of our own public sector R&D to come up with comparable gm matchs despite investing money and effort for two decades. We meekly submitted and started promoting Bt at the ICAR level as if we were their sales agents. Our indigenous efforts at producing Bt and non-Bt alternatives were dismal. WHY DO YOU THINK THIS IS AN ISSUE - we would not be debating here if this was not an issue, Sir.
100	Rajeev Taggar 29/01/23, 10:48	Good morning Dr Kulkarni, Thanks for introducing yourself. We are indeed lucky to have you here. Hope to learn much from you. Regards Group admin
101	Rajeev Taggar 29/01/23, 10:49 Re: Sharad Deshpande 29/01/23, 09:44	Exactly, we are discussing science here - rest all is the frills. All that matters in mutual respect, no unnecessary appeasement or submissiveness.
102	Suren Tikoo 29/01/23, 10:57	My only additional point, Bt technology doesn't enhance yields but protects us from loss of yield. Yield gains after use of Bt began have been through better genotypes developed by the breeders. In this

		whole Bt tech we must not forget the contributions of breeders. They will continue to enhance germplasm. Lastly I am not against native germplasm being used in breeding , rather pointed it out that the recombination breefing across species hasn't received the attention it deserves. Whether you improve one or the other is as per what we want to achieve and doesn't involve why Bt question. I beg to differ from the conclusion of Dr KRANTI that Bt impact has been modest. The impact has been huge
103	Sachin Kulkarni 29/01/23, 11:19 Re: Ravichandran V 29/01/23, 10:35	Though this is off topic but think it's imp so mentioning here NPK 120:60:60 (2:1:1) will not give you best yield in high yielding hybrids; now a days with repeated intensive cultivation of high yielding varieties on the same piece of land Try NPK dose in 2:1:3 ratio along with Secondary and micro nutrients to see the difference Will discuss in details on this some other day.🙏
104	PJ Kulkarni 29/01/23, 11:20 Re: Suren Tikoo 29/01/23, 10:57	Totally agree Sir. 1. Bt protects yield 2. Hybrids due to Heterosis mechanism impacts yield Therefore, BGII hybrid is a combination of two technologies- Bt(BGII) and Hybrid 3. Derivatives of distant/ wide hybridization are to be exploited for yield (genetic gain), tolerance to abiotic and abiotic stresses (where Bt can not play any role). CICR and many Agricultural University have such source where pre-breeding work is strong- but due to policy decisions/ reluctance not ready to share with private industry working on ethical standards. 4. Need transgenics for oligonenic/ polygenu traits - drought, heat, as well for key diseases like CLCuD in NZ and TSV inCZ+SZ 5. Need hybrids that can match short crop duration ~150 days for doble cropping in a year - will help to double farmers income 6. If Hybrids Seed Production is made easy (and may be appomixis) the other countries like USA, BRAZIL, AUSTRALIA CHINA, will grow hybrids than varieties (this is my personal view). 7. HDPS with mechanical picking seems to be future trend but need to work on plant architectural aspects 8. Also need to focus on Lint yield rather thank seed cotton yield...can easily be achieved.
105	Suren Tikoo 29/01/23, 11:23	👍 Thanks
106	Nagendra S 29/01/23, 11:24	Breeding for the optimum plant type is a very important objective for any crop plant bee it cereals, legumes, vegetables or fruit and timber trees. It has far less attention than required. Plant type should have high harvest index, air, light and input use efficiency. Traditional varieties and wild crop relatives variation is not harnessed enough.

		OP varieties are always better for lower cost of seed production and use of saved seeds by the farmers. There is huge scope of this. Agronomic package of practices must also be optimised with the new plant types, Though farmers usually purchase seeds of even OP Varieties each year, unlike the general impression that only hybrid seeds are procured each year. Of course profit margin will be less. Breeding is a continuous effort as the break down of resistance is a reality for GM and non-GM alike.
107	Ram Kaundinya 29/01/23, 11:55 Re: Ravichandran V 29/01/23, 10:04	We need to consider a few points. 1. A simple calculation on yield increases (even if we set aside the fact that yield is multi factorial in nature) When Bt came we had 9m ha of cotton out of which 6m ha was hybrid. We were producing 12m bales of cotton. By 2015 we touched 12m ha of hybrid Bt Cotton with 36m bales production which was the peak we achieved. Doubling of hybrid acreage and trpling of production. Certain states like AP, Telangana, Gujarat had no OP cultivation. They showed remarkable increase in hybrid yields. Whichever way we calculate the yields went up. After 2015 yields stagnated and are now coming down due to technology fatigue and Pink Bollworm. Regular Technological upgradation was essential which we could not do. (Just imagine during the last 20 years how technologies moved in other fields - we were at Pentium 1 that time. Where are with Intel Core 17, 7th generation. I phone came in 2007 and we are already using I Phone 13 or 14. If we did not progress with these technologies the country would have been backward by a few decades). By not allowing tech upgrades in Cotton we have actually gone backwards. Even pesticide industry has seen very high upgradation of technologies during this period. 2. It is a false argument that yields went up due to fertilizer consumption. When a plant is producing more it needs more nutrition. I have done the calculation of fertilizer consumption per kg production of Cotton during this period. It shows a decline. I was in pesticide industry for 22 years and I have full knowledge of what happened there after Bt came. Cotton dropped from being the largest pesticide consuming crop and gave way to Rice at the top. We should look at consumption in Kg a.i/ha and see how it dropped. Value of mkt does not give a good indication as prices of pesticides almost tripled during this period, many new products entered mkt, old tech cheap products like Monocrotophos, Chlorpyriphos, Endosulfan, etc are phased out. Tech upgradation in pesticide industry during last 20 years is phenomenal. 3. No one prevented public institutions from bringing high quality cotton OPVs during this period (quality of rice OPVs from public institutions is so good that rice hybrids could not make much headway.....just for comparison).

		4.We should not look at pieces of the situation in advanced countries and recommend here. There are only 19,000 cotton farmers in US. It is much easier to manage technologies there. Here we have 70 lakh cotton farmers. So the technology providers are more careful here. 5. No technology is perfect. Technology keeps improving with time. It would be unwise not to use technologies as they keep emerging. The world used DDT 60-70 ,years back and the scientist who developed it got Noble Prize!!!. We stopped using it once we developed better technologies. The pesticides we use today are far far superior to what I sold 30 years back. That is science. That is life. It is a very complicated subject. But the bottom line is to keep using and improving technologies.
108	Suren Tikoo 29/01/23, 11:59	In toal agreement. 👌👍
109	Rajeev Taggar 29/01/23, 12:09	Totally agree Sir!
110	PJ Kulkarni 29/01/23, 12:14	👍, When our defense strategy dependent currently on fighter jets from France, Russia etc and also simultaneously working on Tejas...in a similarly way Agricultural Research have to move on without any bias whether technology is indigenous or imported. Provided that it should be pro-farmer, safe to all consumers, cost effective and without any hidden agenda.
111	Ravichandran V 29/01/23, 18:59	Dr Kranthi and Stone: 4.There was an initial and drastic drop in insecticidal sprays of Bt-cotton for few years. American bollworm (ABW) was effectively checked (2002-2009). However, 2009 onwards pink bollworm (PBW) began to show up and became a serious issue soon enough, which continues till date. Concurrently, the attacks by sucking insects also became a major problem. My reply : The three boll worms viz Helicoverpa, Spotted Bollworms and Pink Bollworms were the deadly pests which devastated our crop. Helicoverpa & Spotted Bollworms are polyphagus insects, while Pink Boll Worm is an exclusive pest of cotton. Though we were given a non Bt Cotton seed to be sown as refugia, most of the farmers ignored sowing the refugia as they feared it would be affected by boll worms. Unfortunately they were not educated properly about the purpose of sowing the non Bt Cotton seed. Over the period of time in areas where refugia were not sown, the Bt Cotton developed resistance against PBW. In our area with the help of the seed companies we formed a Smart Cotton Farmer Club and created awareness about sowing Non Bt Cotton. In our area not even a single case of PBW incidence was noted. We represented to the GEAC that the refugia seed must be mixed with Bt Cotton, so that the farmer sows Non Bt Cotton automatically.

		Bt Cotton is meant to address the bollworms only. It is not meant for sucking pest. Therefore Bt Cotton is not responsible for the incidnce of sucking pest. However, in my farm as I don't spray any insecticide to control bollworms which is automatically taken care of by Bt Gene, the non target insect predators are preserved, which prey upon some of the sucking pests.(This observation by me needs further validation)
112	Rajeev Taggar 29/01/23, 19:11	Ok, you basically agree with the observation put forth by Kranthi & Stone, 2020, but have given a likely explanation about why this happens. The refugia strategy is effective, this has been proven already. That sucking pest can be controlled using refugia is a new proposition by you!! Good job ....let the jury be out.
113	PJ Kulkarni 29/01/23, 19:13 Re: Ravichandran V 29/01/23, 18:59	Thanks Ravichandran Ji. We also need to take in account 4th bollworm- Spodoptera (having two species in existence- Spodoptera litura and Spodoptera exuguva) which is also controlled by BOLLGARD II tech.
114	Ravichandran V 29/01/23, 19:22 Re: Rajeev Taggar 29/01/23, 19:11	Where did I say the sucking pest can be controlled by refugia? Where from you inferred this weird observation?
115	Suren Tikoo 29/01/23, 19:23	Thank you.
116	Ravichandran V 29/01/23, 19:28	Yes. There is no incidence of Spodoptera in BG 2. We the farmers trust science and respect scientists. Let the fruits of science and technology reach out our farmers.
117	Rajeev Taggar 29/01/23, 19:29	".... in my farm as I don't spray any insecticide to control bollworms which is automatically taken care of by Bt Gene, the non target insect predators are preserved, which prey upon some of the sucking pests.(This observation by me needs further validation)"
118	Ravichandran V 29/01/23, 19:35	Where is the mention about Refugia. I simply said, I don't spray any insecticide to control boll worm in Bt Cotton as bollworms are taken of by Bt Gene. The non use of insecticide spares nontarget insect predators. Hope I made myself clear. My statement is misinterpretted.

119	Ravichandran V 29/01/23, 19:49 Re: Rajeev Taggar 29/01/23, 19:29	Mr Taggar ji, This is in response to Kranthi's following allegation. Dr Kranthi and Stone 4. .....Concurrently, the attacks by sucking insects also became a major problem. You have quoted my following reply. Mr Taggar, could you show where I mentioned about refugia in my reply!!!! ".... in my farm as I don't spray any insecticide to control bollworms which is automatically taken care of by Bt Gene, the non target insect predators are preserved, which prey upon some of the sucking pests.(This observation by me needs further validation)"
120	Sachin Kulkarni 29/01/23, 20:28 Re: Ravichandran V 29/01/23, 18:59	Good point👍 one thing I read in past about refuge seed supplied by companies is it also contains bt gene traces (either mixed in bag or separate) how to control that 🤔
121	Sachin Kulkarni 29/01/23, 20:28	Reference: 5 Reference: 1
122	Nagendra S 29/01/23, 20:54 Re: Sachin Kulkarni 29/01/23, 20:28	Refugia and gene stacking are approaches to delay the development of resistance in pest. The first one by reducing the selection pressure so that to maintain sustainable pest population and the second one by increasing the selection pressure so that the pest will be kill by the second gene if it developed resistance against the first one and there will be no buildup of resistance pest population. Second approach is more effective. Delaying development of resistance by using refugia approach has the problem just pointed out. One is of course the seed quality control as pointed out but second one is reluctance of the farmers to grow it even if supplied. To prevent this it has been suggested to mix the non-GM sensitive isogenic hybrid (the refugia) in the GM seed itself so that sensitive pest population will maintained on these and resistance development will be delayed.
123	Sachin Kulkarni 29/01/23, 21:01	That exactly the point is even farmers are educated on this and willing to sow *if there is no good quality bt traces free refuge available to plant with BT crop* how one can expect delayed resistance development in pest for this toxin I am not expert but as layman these points come to my mind👆 Pest develops resistance when there is an underdose and if Refugee is contaminated with the traces and not develop strong BT toxin (as regular Bt) then the resistance development will be accelerated then whole purpose of giving refuge is counter productive If they are not pure Non BT

124	Rajeev Taggar 29/01/23, 21:11 Re: Ravichandran V 29/01/23, 19:49	Shall get back to it Sir.
125	Rajeev Taggar 29/01/23, 21:12 Re: Sachin Kulkarni 29/01/23, 21:01	Good point - How effective is the refugia and why? This may also be looked at in the context of the fact that we discussed before - that transgenes spread everywhere, even to the wild relatives.
126	Ravichandran V 29/01/23, 21:31 Re: Nagendra S 29/01/23, 20:54	Another reason for PBW developing resistance to Bt Gene few years back. In the initial years we were not provided with Non Bt Cotton seed to sow them as refugia. The seed companies provided us with Duvarai (It is a Tamil word. I don't know how it is called in Hindi. I presume it is Dhuvar !!!), just to comply with GEAC directions. Helicoverpa and Spotted Bollworms alone devour on this legume. However PBW are the exclusive pest of cotton and they are not the common pest in dhuvarai. Even if we wished to sow non Bt Cotton, we didn't have the choice of sowing it as refugia as we were given only dhuvarai. That is one the reasons for PBW developing reveloping resistance. We brought it to the notice of GEAC, which inturn directed the seed companies to provide non Bt cotton seed and not dhuvarai. Now this problem of skipping the refugia cotton seed doesn't arise at all as non Bt cotton seed is mixed with Bt Cotton seed. Ever since then there is sharp decline in PBW. In our area not even a single PBW moth was trapped in any of the 2000 pheramone traps installed to monitor PBW.
127	Ravichandran V 29/01/23, 21:32 Re: Rajeev Taggar 29/01/23, 21:11	🙏
128	PJ Kulkarni 29/01/23, 21:41 Re: Rajeev Taggar 29/01/23, 21:12	Dr Rajeev, My comment specifically on transgene spread in wild relatives. It a rumor/ unscientific statement wrt cotton / Bt cotton. Please note that it is a proven fact that Bt gene / BGII gene is available in G. hirsutism only. G. hirsutism is a allotetraploid and cross compatible with G. barbadese (Egyptian cotton/Giza cotton just for understanding),

		however, till date Bt gene (both cry1Ac and cry2Ab) are not getting transferred to G barbadense with attempted efforts. Now, there is not a remotest possibility to get Bt gene spread in two cultivated diploids (G. arboreum and G. herbaceum). If happens easily, Cotton Breeder will be more than happy. But the fact is it is not possible with natural pollination to get Bt in either barbadense, arboreum and herbaceum. (Cotton is an entomophilous crop, pollen transfer happens only through insects). Next level is of wild species of cotton. Due to genome differences and ploidy level issue (most wild species are diploids barring few) there is incompatibility with G. hirsutism. Hence, the Bt gene spread in wild species is not possible by natural pollination. *Therefore, please delete the understanding that Bt gene from G. hirsutism cotton can spread to other 03 cultivated species and any wild species naturally.* (If i need to be corrected, request experts to share the edits required in my above explanation, please)
129	Nagendra S 29/01/23, 21:51 Re: PJ Kulkarni 29/01/23, 21:41	Good point.
130	Rajeev Taggar 29/01/23, 21:58	Reference: 3 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5033179/
131	Rajeev Taggar 29/01/23, 21:58	"Convincing evidence has accumulated that unintended transgene escape occurs in oilseed rape, maize, cotton and creeping bentgrass. The escaped transgenes are found in variant cultivars, in wild type plants as well as in hybrids of sexually compatible species." "The escape of transgenes was also found in Mexico, where maize landraces contain various transgenes (Table 1), although GM corn is not allowed for cultivation in this country." Reference: 4 DOC-20230129-WA0035. (file attached) 13.093Recentlongdistance...cotton(1).pdf Another one "Transgenes in wild cotton metapopulations" “Fifteen years after the introduction of GM cotton cultivars into Mexico, we have documented the presence of recombinant proteins in wild cotton populations at its CCO (see Fig. 4a). We assayed recombinant protein activity using ELISA kits available in Mexico. These enabled us to detect 18 out of 21 approved events (CERA 2010)

		among individuals of wild cotton populations. The remaining undetectable events (3) have been scarcely sown. The traits that have been introduced, alone or in different combinations, into currently sown cotton varieties through genetic engineering include Lepidoptera resistance (Cry1Ab⁄Ac, Cry2Ac, Cry1F and vip3A), herbicide tolerance (CP4-EPSPS), and antibiotic resistance (PAT⁄Bar, nptII and aph4; Traxler & GodoyAvila 2004)."
132	Rajeev Taggar 29/01/23, 22:11 Re: PJ Kulkarni 29/01/23, 21:41	The evidence is over-riding, not remotest. Please see above.
133	Vinod Patel 29/01/23, 22:16	Refugia is wonderful for save technology but it was not properly adopted by seed companies as directed by regulatory system. We just supplied as per procedure but unfortunately options given in seperate packet not adopted by farmers.
134	Ram Kaundinya 29/01/23, 22:23	If I am a farmer why would I plant refugia? I have no incentive to lose crop in 25% of my acreage by planting refugia. Quality of refugia, regulatory guidelines make no difference to my immediate financial interests. Seed growing farmers don't like to grow non-Bt cotton seeds for the same reasons. Seed Industry really struggles to get them produced.
135	Vinod Patel 29/01/23, 22:25 Re: Ram Kaundinya 29/01/23, 22:23	Absolutely right 👍
136	PJ Kulkarni 29/01/23, 22:26 Re: Rajeev Taggar 29/01/23, 22:01	I will go thru..thanks.
137	Rajeev Taggar 29/01/23, 22:26 Re: Ram Kaundinya 29/01/23, 22:23	👍 A cause for concern
138	Vinod Patel 29/01/23, 22:28	A few farmers earlier planted only due to lack of knowledge.... when they understand losses ..,than stop

	Re: Ram Kaundinya 29/01/23, 22:23	
139	Sharad Deshpande 29/01/23, 22:35	Dr Rajeev & all, I am quite delighted with the knowledge exchange happening here. We are receiving posts with such a rapidity.. one post approx every 10-15 minutes, all day! I don't know how to cope up with this!🤔 But aren't we finding it difficult to grab and keep pace with the posts?...a non-breeder like me, in particular. Therefore, I'm of the opinion that we should plan a webinar with 3-4 experts on panel and a learned anchor to discuss threadbare the topics (like Bt cotton..).
140	Rajeev Taggar 29/01/23, 23:47 Re: Ravichandran V 29/01/23, 19:49	Ok Sir, nothing to do with refugia here. It was only the surviving beneficial insects preying upon the harmful insects. Appreciate your sharing the observations. We are all so proud of you. 🙏
141	Rajeev Taggar 29/01/23, 23:55 Re: Sharad Deshpande 29/01/23, 22:35	This is a fair remark Sharad Sir. Let us conclude and summarise the topic at hand. Hopefully, we shall fine-tune and smoothen up this exchange of ideas and information.
142	Rajeev Taggar 30/01/23, 00:02	Friends, Perhaps, we can close the debate on Bt-cotton at this juncture. This was indeed a roller coaster ride of ideas, emotions and information-flow. I shall be summarising it all in the coming couple of days. Please feel free to diverge to any other topic on crop improvement. Many thanks indeed for the generous sharing of thoughts. Impartial summarization will be attempted with total honesty to the best of my abilities. 🙏
143	Nilasis Ghoshdastidar 30/01/23, 08:16	Long back, when we heard about the refugia concept in one of the IBSCs, I could not check myself to predict that neither the farmers will plant refugia bags, knowing that its plants would be susceptible, nor it would be easy to maintain the logistics. When asked about a remedy, I suggested for producing F2s of the same hybrid and mixing it in a 25% ratio, much to the chagrin of the elderly! However, it

		might work for a monogenic dominant trait only, when only one parent had the gene.
144	Rajeev Taggar 30/01/23, 09:45	Mixing 25% F2 of the same hybrid as refugia for monogenic transgenic traits - sounds like a good idea !! Why are such suggestions overlooked and trashed? Sad. You were probably ahead of the times. This made so much sense over 20 years back when GMOs had not been released in India at all.
145	Nilasis Ghoshdastidar 30/01/23, 09:51	You may remember I was always full of ideas. And, many a times had to face criticism! 😀But, in India, there is rarely any value for out of box thinking. 😉
146	Rajeev Taggar 30/01/23, 09:54	You are not alone Nilasis. This is the story of life. As growing youth most people are bullied and snubbed into silence. Now is your time to shine. Speak out.
147	Nilasis Ghoshdastidar 30/01/23, 09:54	😀🙏
148	Raghavendra Sandhikar 30/01/23, 09:59	Those people who try to do things differently are always gifted ones…. Such people are highly valued and can contribute largely only if they continue without being frustrated. Please keep up and keep innovating!!!
149	Rajeev Taggar 12/02/23, 13:14 Re: Nilasis Ghoshdastidar 30/01/23, 08:16	F2 as refugia: This may not be feasible practically, because: 1. Identifying 25% Bt recessive F2 would require PCR or Basta screening. Doing PCR would mean additional costs and may not be even a practical possibility since this would mean doing seed-based PCR on F2 mustard seeds, which are so small sized. Basta screening on F2 seeds is not even possible, the F2 seeds would need to be sown to raise seedlings which will then be screened for Basta. 2. Using unscreened F2 is an option but that again is practically unfeasible because that would require farmers to use 4 times the orginal amount of refugia required to get the same output of refugia. Rest 3/4 of the seeds would be F2 replacing their F1 seeds. This would mean compromising on the heterotic advantage of F1 seeds.
150	G Laxmi Devi 12/02/23, 13:34	👍
151	Nilasis Ghoshdastidar 30/01/23, 08:16 Re: Rajeev Taggar 12/02/23, 13:14	Suggested for Cotton. Not Mustard. In mustard refugia was and is not needed. Not difficult. I can prepare a flow chart/ SOP easily. 😉

152	Rajeev Taggar 12/02/23, 15:03	Ok Cotton. So the seed size will not be an issue. Yet, the same above two points will remain valid. Easy SOP - ok, for this debate, we shall keep it as a suggestion.
153	Nilasis Ghoshdastidar 30/01/23, 15:47	Why do u need to screen an F2? If the Bt gene is put only on one parent, what should be the natural outcome in F2? Do u need to screen? And, it will be randomly spread out so farmers couldn't rogue them out intentionally. And, why bother for any loss? The refugia concept itself accepts and intends loss. No?
154	Rajeev Taggar 12/02/23, 15:32 Re: Nilasis Ghoshdastidar 30/01/23, 15:47	Now we are discussing why use F1 and not F2. As I stated, even mixing F2 as refugia in F1 will carry heterosis loss. Without screening, the size of refugia will become four times the initial refugia requirement. Not sure if the farmer would accept this loss in heterotic yield or even the seed companies would like to add this F2 contamination in F1. Only 1/4 of the F2 seeds will be recessive for the Bt gene. Not just that, when more than one transgenes are used, which is the case now, the spread of transgenes will be uneven across F2 segregating population. In such a condition, F2 as refugia would be even more difficult, since the transgene recessive F2, which will truly count as refugia, will be even less in number. So, in case of multiple transgenes, the refugia size will be even bigger.

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BRIEF BACKGROUND OF DEBATE PARTICIPANTS

Chandrashekhar Chaporkar	Dr Chandarshekhar Chaporkar is the Head of Research at Maharashtra Hybrid Seeds Company (MAHYCO), Jalna, Maharashtra, India, with many decades of experience as a plant breeder and as research lead.
Dharmendra Daukia	Mr Dharmendra Daukia is an agricultural Engineer turned Forestry professional with over 30 years experience in fast growing hardwood plantations development, wood/bamboo harvest and transport logistics, new business development. India-ASEAN region.
G Laxmi Devi	Dr G Laxmi Devi is an Assistant professor at Dr Y.S.R Horticulture University, Andhra Pradesh, India
Hari Sharma	Dr Hari Sharma is the Former Vice Chancellor, Dr YS Parmar University of Horticulture & Forestry, Nauni, Himachel Pradesh, India. He is also the former President of the Council of International Congresses of Entomology. He was the Head of Entomology (IRS) at the International Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad, India
Manoj Phalak	Dr Manoj Phalak is Head, Regulatory affairs and Breeding Head Okra, Cowpea and Beans at Ankur Seeds Pvt Ltd, Nagpur, India
Nagendra Singh	JC Bose National Fellow, Dr Nagendra Singh is an experienced plant biotechnologist with a demonstrated history of success in plant genomics, agricultural research leadership, research fund raising and project management at an international level. With a Ph.D. from the University of Adelaide, Australia (1981-1985), he is skilled in agricultural biotechnology & innovation, molecular biology, genetics, strategy & regulatory affairs for biotechnology products, institution building, policy making in the area food security and agriculture research. He was National Professor, Dr B. P. Pal Chair, at the National Research Centre on Plant Biotechnology (NRCPB), New Delhi, India. In addition, Dr Nagendra Singh worked as Postdoctoral Fellow and Queen Elizabeth II National Research Fellow at CSIRO, Australia, Associate Professor at GB Pant University of Agriculture, Pantnagar, Uttarakhand, India and Scientist C at the Central Food Technology and Research Institute (CFTRI), Mysore, India.
Nilasis Ghoshdastidar	Mr Nilasis Ghosh Dastodar has been the lead breeder for mustard at Bayer CropScience , India and Namdhrai Seeds Private Limited, India for over three decades.
Om Prakash Dhankher	A former Commonwealth Scholarship fellow, Prof (Dr) Om Prakash Dhanker is a professor in Plant Biotechnology at the University of Massachusetts, Amherst, USA.

Pandurang J Kulkarni	Dr Pandurang Kulkarni is a Plant Breeder with experience in cotton breeding research for 19 years, okra breeding for 5 years and solaneceous crop breeding for 2 years. He developed 37 Bollgard II cotton hybrids for Indian market, 04 Bollgard II hybrids and 06 Non GM hybrids for African market. He has a strong business acumen in designing, planning and executing various breeding projects to deliver successful products. He has been co-ordinating and collaborating Indian as well as African cotton breeding research programs using advance tools and rapid generation advancement. He has a very diverse experience in cotton transgenic breeding with multiple traits. A team player, Dr Kulkarni smoothly coordinates with various functions, internal, external stakeholders and public institutes.
Raghavendra Sandhikar	Presently the Managing director of United Genetics India, Dr Raghavendra Sandhikar is an experienced professional, passionate to develop organizations that have diversified into a new business sector/division (Agri related) to harness emerging opportunities. He has experience of more than 22 years in Agrochemical, Seeds, Biological businesses. The positions he held include Vice President and Head - Strategic Business Unit (Syngenta), Vice President - Solutions (Innovation wing), Business Head / Lead in Seeds. He is an expert in organizational strategy development and product launches. He has worked extensively in India, Bangladesh & Pakistan) He is experienced in a wide range of technologies.
Rajeev Taggar	Mr Rajeev Taggar is an experienced molecular breeder having a strong background in genomics, plant genetics, crop breeding and a broad range of biotechnological tools. He was instrumental in setting-up molecular breeding laboratories and initiating molecular breeding programmes to support crop breeding at Bayer CropScience, India and Green World Genetics Sdn Bhd, Malaysia. He has a proven track record in the use of new breeding tools (NBTs) for crop improvement. He is an expert in setting-up low cost, high efficiency molecular breeding facilities. He got trained in reputed research laboratories from UK, Germany, India, and Netherlands. Presently, he heads Saikap Biotech, a start-up devoted to training & consultancy for molecular breeding and plant biotechnology.
Ram Kaundinya	Mr Ram Kaundinya has served in the senior most positions in multiple national and International organizations, including Advanta India, Monsanto India, Emergent Genetics and Cyanamid India / BASF Agro. He was the Chair of ABLE- AG, which was involved with Policy Advocacy work for Agri Biotechnology in India. Currently he is the Director General of the Federation of Seed Industry of India (FSII).
Ravichandran Vanchinathan	Mr Ravichandran Vanchinathan is progressive farmer. He has been farming for over 35 years. He is Director of the Global Farmers

	Network. He is the proprietor of VKV farms. He has been the voice of Indian farmers at multiple national and international events.
Sachin Kulkarni	Mr Sachin Kulkarni is the Managing Director of ProActive Agri Solutions Pvt Ltd. He is an expert in crop production and farming practices, with demonstrated experience in Soil Chemistry & Fertility, Plant Nutrition & Fertigation management. Hydroponics, hybrid seed production.
Sharad Deshpande	Mr Sharad Deshpande has worked as Regional Sales Manager & Product Manager (Corn) in Syngenta. He was General manager at Kaveri Seeds and Business Lead at SBU Seeds and Mahindra & Mahindra. Trained at NABARD and College of Agriculture Banking (CAB-RBI), he has interacting closely with the farmers all over India.
Suren Tikoo	Dr Suren Tikoo is a research manager for crop improvement using breeding & technology to speed up new product development. He has over 40 years' experience in public & private sector as a breeder & research leader. He developed nationally released tomato varieties and hybrids in India, USA and Turkey. He has over 40 research publications to his credit. He guided several students to their PhD and Masters degrees in 80's. Presently, Dr Suren Tikoo is Founder & Research AdvisorFounder & Research Advisor for Tierra Agrotech Limited. He was Global Research Head, Vegetable Seeds at Advanta India Limited, Vice President & Head, Vegetable Research, Syngenta India Ltd and Chief Solanaceous Lab & Principal Tomato Breeder at IIHR, Bangalore, India.
Vinod Patel	Mr Vinod Patel is a senior cotton breeder. He has been leading cotton breeding in various reputed Indian seed companies, including Nath Bio-Genes, Krishidhan Seeds and Markiv Seeds for nearly three decades.