Open letter to Niti Aayog (National Institution for Transforming India) – an Indian Government think tank

From: Prof. Andrew Paul Gutierrez
Dr. Hans R. Herren
Dr. Peter E. Kenmore
4 August 2020

A 6 July 2020 article in the business-oriented BloombergQuint reported an interview with Dr. Ramesh Chand, a member of the Indian Government think-tank Niti Aayog (National Institution for Transforming India), and an earlier article on 17 July 2019 ("Feeding 10 billion people will require genetically modified food"), require a responsible and factual response. The articles reported sweeping unsupported claims concerning the benefits of, and need for, genetic engineering and related technologies in agriculture in India, and further asserted that Bt cotton was a grand success and an example of the potential of biotechnology. Dr. Chand is reported as stating that India has three pressing needs: improving farm efficiency, sustainability and food security, and further that a "positive environment" [is] developing in India as there is no credible study to show any adverse impact of growing Bt cotton in the last 18 years in the country...".

We agree that there is a need to improve farm efficiency, sustainability, and food security, but in contrast, all of the credible evidence shows that the meager increases in cotton yield after the introduction of Bt cotton in 2002 were largely due to increases in fertilizer use (Kranthi 2016; Kranthi and Stone 2020), and there are other serious shortcomings addressed below. [N.B. Dr. K.R. Kranthi was the former head of CICR at Nagpur and Professor G. Stone is an international expert on socio-economics of farming systems.]

The Chand interview occurred at a book release event for a new volume titled Socio Economic Impact Assessment of GM crops: Global Implications Based on Case Studies from India, edited by Drs. Sachin Chaturvedi and Krishna Ravi Srinivas of the Delhi-based Research and Information System (RIS) for developing countries, an agency that is a policy research think tank in the Ministry of External Affairs, Government of India. Hence, what Niti Aayog and RIS representatives say and write is existentially important because of their deep links to Indian policy makers, and hence the large impact on the future development of policy in the area of genetic engineering and related technologies such as genomic editing – policies that will impact the health, livelihood, and welfare of Indian farmers and the Nation far into the future.

In the interview, Dr. Chand posits that "opposition and uncertainty" to GM technology lingers because “the technology is so powerful that it has created fear in the minds of people”; that “GM technology came at the time of the IT revolution due to which global views were available on internet platforms and the government stayed away from it as the technology was opposed globally”; and that “the media relied more on activists than on scientists”. We respectfully submit that these are not strong arguments and are materially inaccurate.

For fairness, we also review the Chaturvedi–Srinivas edited RIS volume. In contrast to the statements reported in the press articles above, most of the chapters contain some points that temper or criticize the over-simplified enthusiasm of GMO promoters. A brief study of the book revealed the following findings:

A. The general policy position, that Bt cotton is a paradigm for benefits to smaller and poorly connected farmers, was not always supported by the case study data in the book.
A-1. Not all farmers enjoyed economic or income benefits from Bt cotton: Chapters 1 and 4.
A-2. Bt cotton YIELDs were not higher (than non-Bt cotton) for all farmers within one season: Chapters 4 and 10.
A-3. Average yields for Bt cotton in the same farmers’ fields declined over recent years: Chapters 1, 8, and 10.

B. Even when economic gains were made by Bt cotton farmers, it was not demonstrated that those gains came from Bt traits: Chapter 11 (surveying the Bt cotton case studies in this book.)

B-1. Higher fertilizer levels usually increased yields in field studies: Chapters 1, 8, and 10.
B-2. Bt cotton is “irrigation intensive” compared with non-Bt cotton: Chapters 1 and 5.
B-3. Bt cotton benefited larger farmers more than smaller farmers: Chapters 8 and 10.
B-4. Bt cotton showed INCREASING Returns to Scale (i.e. NOT Scale Neutral), thus benefiting larger, richer, better connected farmers: Chapter 8.

C. Farm input and output prices in India are influenced by a variety of governmental restrictions, subsidies, taxes, credit access and other instruments. Farmers’ opinions, governmental interventions, and larger private/corporate rent-seeking and protection push against each other regarding Bt cotton.

C-1. High Bt cotton seed prices concern most farmers interviewed: Chapters 1, 4, 5, and 8.
C-2. Monopolistic pricing practices and seed patent rights owned by larger seed companies limit benefits to Bt cotton farmers: Chapters 3, 4, 5, and 7.

C-3. Prices received by farmers for Bt cotton were lower than for non-Bt cotton: Chapters 5 and 10.

D. As described by a Parliamentary Commission: “All is not well with regulatory and governance mechanisms” for GMO crops: Chapters 4 and 7. For example:

D-1. Bt seed prices are regulated by government interventions to reduce the maximum price seed companies can charge: Chapters 1, 3, 4, 7, and 8.
D-2. There is need to improve involvement of farmers and local village government in regulating GMO crops: Chapters 3, 4, 5, and 12.
D-3. Regulatory innovations at global, national, and local levels (ecotoxicology, pesticides, pollution) are relevant for improving GMO regulations to protect farmers and consumers: Chapters 4 and 11.

The volume has limited scientific value and is written for people with inside knowledge. All of the authors are social scientists who evaluated data and analyses by other social scientists to develop RIS “Guidelines and Methodologies for Socio-Economic Assessment” for use in policy development. Nowhere in the text did scientists in agronomy, entomology and related disciplines provide in-depth analysis of the posited benefits of GMOs, except in industrial agriculture in developed countries (Shelton et al. 2002); results that have little applicability to conditions in India. The authors and the social scientists cited fail to acknowledge that the issues of crop production and protection are first and foremost ecological in nature, and this sets the basis for what is possible at the economic and social scales. Nowhere in the volume was the biology-ecology of crop production systems assessed. The reports of field trials in India reporting the benefits of GMO technology were based largely on meta, ex ante, ex post and post hoc studies conducted by agricultural economists producing lots of nice round numbers lacking holistic assessment at different scales. The RIS volume cited gains in yield and reductions in insecticide use in Bt cotton that are inaccurate, and further are method-, time-, and place-specific (see Gutierrez et al. 2017; Kranthi and Stone 2020). Only in Chapter 1 was a result critical of the overall impact of the Bt technology in India reported (Sahai and Rahman 2003). The thoughtful Chapter 4 by Dr. E. Haribabu on public perceptions of risk is excellent.

There is also considerable emphasis on Article 26 of the Strategic Plan for the Cartagena Protocol on Biosafety (2011-2020) (CPB) envisaged to protect the right of Parties (nation states) by taking into account socio-economic considerations in the transboundary movement, development, and impact of Living Modified Organisms (LMOs) on the conservation and sustainable use of biodiversity. Unfortunately, it is apparent from the RIS text that India wishes to interpret the CPB to address limitations on GMOs raised by various stakeholders within India, allowing, based on presumed ‘socio-economic considerations’, the unrestrained development of indigenous LMOs (i.e. GMOs). That was the main focus of the RIS volume.

Dr. Chand and much of the RIS volume cite the presumed grand success of Bt cotton as a template for introducing GMO (and gene editing) technologies in other crops (mustard, brinjal, etc.), often using questionable methods to gain registration for GMO chimeras (e.g., Pental 2019; see a reply by Gutierrez et al. 2020). Proponents of Bt cotton's success point to increases in national production, and yet the true measures of how well farmers are doing should be scale neutral with yield and total net income per hectare being appropriate metrics, and proper accounting of costs of ecosystem and biodiversity losses should be considered. When viewed from an objective perspective, a failed picture emerges of an unsustainable eco-social Bt cotton system based on a dystopic relationship between those who control and sell the inputs, and the vast majority of farmers that given their level of information and education attempt to implement them. Nowhere in the volume is there mention of potential viable non-GMO systems alternatives.

Below the "success" of Bt cotton in India is reviewed based on deep analyses of the effects of weather, ecological and agronomic factors. We apologize for self-citations, but not all scientists (including in the USA) have the freedom to express opposing views as freely as did the biotechnologist Dr. Deepak Pental in his strongly worded critique against very prominent, globally respected and honored Indian scientists Dr. P. C. Kesavan and Dr. M. S. Swaminathan (see Pental 2019; Gutierrez 2020). In order of importance questioning the success of hybrid Bt cotton are: (1) the field trial data on high yielding short-season high-density (SS-HD) non-hybrid non GMO cotton by CICR's Venugopalan et al. (2011); studies that clearly show the availability of highly viable alternatives to hybrid GMO Bt cotton (see Fig. 4 below); (2) the analysis of the long-term national and state data on the impact of Bt cotton in India by Kranthi and Stone (2020; see Gutierrez et al. 2017) that lays bare the fallacy of the Bt cotton myth in India; (3) the bioeconomic studies of Bt cotton in India (Environmental Sciences Europe (Gutierrez et al. 2015)); and analyses in Current Science India (Gutierrez et al. 2017, 2019) that deconstructed the unsustainable econ-ecological bases of the current Indian Bt cotton production system. We note that at least 25-30 peer reviewed papers have been published recently in India from almost all the agricultural universities dealing with cotton, validating the SS-HD concepts using non-Bt varieties (see the partial list of publications below). In all of the studies, SS-HD plantings invariably got the highest yields, clearly pointing to the inappropriateness of the current low-density system. Yet, none of these studies were cited in the Chaturvedi–Srinivas RIS volume.

In chronological order, the results of the bioeconomic investigations of Bt cotton clearly show:

1. Hybrid cottons unique to India were introduced in the mid-1970s purportedly to

increase yield and quality, but the hybrid seed is considerably more expensive due to royalty and technology costs, the plants require more fertilizer and stable water, and the hybrid technology serves as a value capture mechanism requiring annual purchases of seed (Gutierrez et al. 2015; in press). This problem will recur for hybrid GMO varieties proposed for other crops (see Gutierrez et al. 2019).

2. Indian farmers are planting inappropriate long season hybrid cotton varieties at inappropriate low planting densities due to high seed costs. This contributes to low yield stagnation (see Venugopalan et al. 2011, Gutierrez et al. 2017; Kranthi and Stone 2020).

3. Pre-2002, insecticides were used to control the native pink bollworm (PBW, i.e. the key pest) in long season hybrid cotton. As occurred worldwide, insecticide use causes ecological disruption that in India induced outbreaks of secondary insect pests (i.e. normally non pests) like the highly damaging "American" bollworm (and others). Farmers were spending money on insecticides to lose money from (insecticide) induced pests. To solve the insecticide induced American bollworm and other induced moth problems (e.g., PBW), GMO Bt cotton was introduced starting in 2002. We note that illegal Bt seed was introduced in Gujarat before 2002 (see RIS Chapter 4)

4. While the Bt technology initially solved the bollworm problems, outbreaks of secondary pests not controlled by the Bt toxins began to occur, again increasing insecticide use in Bt cotton that by 2013 surpassed pre-2002 levels. This caused ecological disruption and induced outbreaks of still newer secondary pests (whitefly, jassids, mealybug), and increased levels of resistance to insecticides. By 2013, Indian farmers were solidly on both the insecticide and biotechnology treadmills. And yet, some technologists still propose that developing pest issues could be fixed with still further biotech fixes – a proposal akin to a technological dog chasing its own tail. Data on points 1-4 are depicted in Figure 1.

Figure 1. Trends of national cotton yield, Bt cotton adoption and total insecticide use on cotton with the quantities partitioned as to the target pests (bollworms (black line) vs sucking insects (i.e. hemiptera - red line)) (Ministry of Agriculture data)

5. Bt cotton did not increase yields, but did contribute to increased cost of production (Figure 2), all in the face of stagnant yields (see Figure 1) leading to

economic distress.

Figure 2. Ministry of Agriculture data on national costs of production against a background of percent Bt cotton adoption (solid line) and stagnant yields (see Figure 1).

6. Analysis of the available statewide and national data show that suicides among Indian cotton farmers increase with decreasing yield and net revenues (i.e. economic distress; Figure 3; Gutierrez et al. 2015, in press; see also Sadanandan 2014).

Figure 3. Correlation of Indian cotton farmer suicides with (a) cotton yield and (b) net revenues (Indian rupees, Rs = ₹) for the period 1999-2014 across the south-central Indian states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, and Maharashtra (Gutierrez et al. in press). The data in the dashed area in (a) are from Gujarat.

7. High density, short season (HD-SS) NON-GMO pure line rainfed cotton varieties have been developed in India that could double yield (CICR data; Figure 4) and triple net income. The average yield of the current hybrid varieties in Maharashtra is shown for comparison. The obvious question is – Why haven't these varieties been developed and implemented in the field?

Figure 4. Published data from CICR, Nagpur, Maharashtra (Venugopalan et al. 2011). The average yield for Maharashtra (MH) was superimposed to illustrate the yield gap.

8. The potential exists for development of even higher yielding HD-SS non-hybrid non-GMO varieties in India; varieties that would allow seed saving by Indian farmers.

9. Incorporation of hybrid and Bt technologies in HD-SS cottons would not give economic benefit because there would be no increase in yield, seed cost would be 6-

8fold current costs, and rainfed HD-SS varieties would avoid infestation by the key pest pink bollworm obviating the need for the Bt technology (see Gutierrez et al. 2015).

10. Resistance to Bt cotton in pink bollworm is now widespread in India, and resistance to insecticide in many pests is increasing (Kranthi 2014; Naik et al. 2018).

By nearly all measures, hybrid Bt cotton in India is a failure, or at best very suboptimal for farmer welfare. Despite increases, Indian yields are no more than some of the poorest African countries which do not cultivate hybrid cotton or Bt-cotton. In 2017, 31 countries were ranked above India in terms of cotton yield (i.e. kg ha–1), and of these, only 10 grew GMO cotton (Kranthi 2014). So why is hybrid Bt cotton falsely used as an example of a grand success, and why should it be used as a template for implementing the hybrids, GMOs, gene editing and other technologies in other crops – especially food crops? Why have legitimate concerns been ignored about the loss of biodiversity and of the irreversible GMO contamination of indigenous crop varieties and wild species. Why has the emphasis been on GMO development when viable alternatives are available but remain largely unexplored? Much of biotechnology in agriculture is an exercise in linear thinking and reductionism, of unexpected consequences; the eco-social manipulations of the RIS volume aside. There is a need to use caution and back up any decision that affect the food and nutrition security of over a billion people with strong science, farmers' knowledge and experience as well as an understanding of the possible conflicts of interest (IPES-Food 2016) at play to the detriment of the Indian agricultural sector, the public, and the Nation.

References

Gutierrez AP, Kenmore PE, Rodrigues A (2019) When biotechnologists lack objectivity. Curr Sci 117:1422–1429

Gutierrez AP, Ponti L, Baumgärtner J (2017) A critique on the paper 'Agricultural biotechnology and crop productivity: macro-level evidences on contribution of Bt cotton in India.' Curr Sci 112:690–693

Gutierrez AP, Ponti L, Herren HR, et al (2015) Deconstructing Indian cotton: weather, yields, and suicides. Environ Sci Eur 27:12. https://doi.org/10.1186/s12302-015-0043-8

Gutierrez, A.P., Luigi Ponti, Keshav R. Kranthi, Johann Baumgärtner, Peter. E. Kenmore, Gianni Gilioli, Antonio Boggia, Jose Ricardo Cure, Daniel Rodríguez (submitted) Bio-economics of Indian hybrid Bt cotton and farmer suicides. Environ

Sci Eur

Gutierrez AP, P.E. Kenmore and A. Rodrigues 2020, Commentary – A reply by Gutierrez et al. Curr. Sci., 118(6)

IPES-Food. 2016. From uniformity to diversity: a paradigm shift from industrial agriculture to diversified agroecological systems. International Panel of Experts on Sustainable Food systems. http://www.ipes-food.org/_img/upload/files/UniformityToDiversity_FULL.pdf

Kranthi KR. Cotton production systems—need for a change in India. Cotton Statistics & News. 2014;38(16 December 2014):4-7. http://caionline.in/newsletters/issue_38_161214.pdf. Accessed 27 March 2014.

Kranthi, K. R. (2016) Fertilizers gave high yields, Bt only provided cover. Cotton Stat. News. 39, 1-6. http://www.cicr.org.in/pdf/Kranthi_art/Fertilizers_and_Bt.pdf (Accessed 10 December 2018).

Kranthi K.R., Stone G.D. (2020) Long-term impacts of Bt cotton in India. Nat Plants 6:188–196. https://doi.org/10.1038/s41477-020-0615-5

Naik VC, Kumbhare S, Kranthi S, et al (2018) Field-evolved resistance of pink bollworm, Pectinophora gossypiella (Saunders) (Lepidoptera: Gelechiidae), to transgenic Bacillus thuringiensis (Bt) cotton expressing crystal 1Ac (Cry1Ac) and Cry2Ab in India. Pest Manag Sci doi:10.1002/ps.5038. https://doi.org/10.1002/ps.5038

Pental, D., (2019) When scientists turn against science: exceptionally flawed analysis of plant breeding technologies Curr. Sci., 117, 932–939; doi:10.18520/cs/v117/i6/932-939.

Sadanandan, A. (2014). Political economy of suicide: Financial reforms, credit crunches and farmer suicides in India. The Journal of Developing Areas, 48(4), 287–307. http://search.proquest.com/ docview/1523669376?accountid=79789.

Sahai, S. and Rahman, S. (2003). Performance of BT cotton in India: Data from the First Commercial crop. Gene Campaign.

Shelton, A. M., Zhao, J. Z., & Roush, R. T. (2002). Economic, ecological, food safety, and social consequences of the deployment of Bt transgenic plants. Annual Review of Entomology, 47(1), 845–881.

Stone, G. D. (2012, September 22). Constructing facts Bt cotton narratives in India. Economic and Political Weekly, XLVII (38).

Venugopalan, MV, Prakash AH, Kranthi KR, et al (2011) Evaluation of cotton genotypes for high density planting systems on rain fed vertisols of Central India. In: Kranthi KR, Venugopalan MV, Balasubramanya RH, et al (eds) World Cotton Research Conference. International Cotton Advisory Committee, Mumbai, India, pp 341–346.

A partial list of papers on SS-HD cotton research in India

Ahuja, S. L., Monga, D., Meena, R. A., Rishi Kumar and Neha Saxena 2013. Evaluation of G. arboreum cotton genotypes for High Density Planting Systems in Northern India. National Symposium on “Technology for Development and Production of Rainfed Cotton” 24-25 October, 2013, RCRS, NAU, Bharuch: 9.

Alur, A., Halepyati, A.S., Chittapur, B.M., Nidagundi, J.M. and Koppalkar, B.G., 2020. Effect of high density planting and nutrient management on growth and yield of compact cotton (Gossypium hirsutum l.) Genotypes. Journal of Pharmacognosy and Phytochemistry, 9(4), pp.294-297.

Desai, H.R., Bhanderi, G.R., Patel, R.D., Sankat, K.B. and Patel, R.K., 2019. High density planting with insecticide resistance management approach for sustainable and profitable cotton production in rain fed region. Journal of Entomology and Zoology Studies 2019; 7(5): 453-458

Ganvir, S. S., Khargkharate, V. K., Ghanbahadur, M. R., Tamgadge, J. B. and Nage, S. M. 2013. Effect of high density planting, nutrient management and In-Situ moisture conservation on productivity of hirsutum cotton. National Symposium on “Technology for Development and Production of Rainfed Cotton” 24-25 October, 2013, RCRS, NAU, Bharuch. p. 85.

Harshana, A., Patil, S.B. and Udikeri, S.S., 2017. Validation of existing IPM module of cotton under high density planting system. Journal of Entomology and Zoology Studies, 5(5), p.687.

Maheswari, M.U. and Krishnasamy, S.M., 2019. Effect of crop geometries and plant growth retardants on physiological growth parameters in machine sown cotton. Journal of Pharmacognosy and Phytochemistry, 8(2), pp.541-545.

Nalayini, P. and Manickam, S., 2018. Agronomic manipulation of high strength cotton genotype, CCH4474 for yield maximization under irrigated agro ecosystem of

Coimbatore. Journal of Cotton Research and Development, 32(2), pp.256-259.

Nemade, P., Rathod, T., Deshmukh, S., Paslawar, A., Ujjainkar, V., Deshmukh, V. And Jayle, S., 2015. Evaluation of spacing and spray schedule for management of bollworms in HDPS cotton. Book of Oral Presentations, p.165.

Parihar, L.B., Rathod, T.H., Paslawar, A.N. and Kahate, N.S., 2018. Effect of High Density Planting System (HDPS) and Genotypes on Growth Parameters and Yield Contributing Traits in Upland Cotton. Int. J. Curr. Microbiol. App. Sci, 7(12), pp.2291-2297.

Paslawar, A. N., Patil, B. R., Ingole, O. V., Nemade, P. W. and Deotalu, A. S. 2013. High Density Planting System for AKH-081 and its influence on Growth, Yield and Economics under rainfed cultivation. National Symposium on “Technology for Development and Production of Rainfed Cotton” 24-25 October, 2013, RCRS, NAU, Bharuch. p. 74.

Pawar, N.D., Jiotode, D.J., Kubde, K. J., Khawle, V.S., Puri, P.D. 2017. Effect of plant geometry under HDPS on crop phenology and yield contributing characters in cotton. Journal of Soils and Crops 2017 Vol.27 No.1 pp.274-280

Pradeep Kumar., Karle, A.S., Sing D. and Verma, L. 2017. Effect of high density planting system (HDPS) and varieties on yield, economics and quality of desi cotton. Int. J. of Curr. Microbio. and Applied Sci. ISSN: 2319-7706 Volume 6(3): 233-238.

Santhosh, B., Thatikunta, R., Reddy, D.V.V., Hussain, S.A. And Shankar, V.G., 2019. Physiological Basis of Improved Yields. In Rainfed Cotton Under High Density Planting System. The J. Res. Pjtsau Vol. XLVII No. 3 pp 1-70, July-Sep., 2019, p.12.

Venugopalan, M. V., Blaise D., Tandulkar, N. R. and Shubhangi, L. 2013. HDPS [HD-SS]- A promising option for Rainfed Cotton. National Symposium on “Technology for Development and Production of Rainfed Cotton” 24-25 October, 2013, RCRS, NAU, Bharuch : L-3.

Venugopalan, M. V., Kranthi, K. R., Blaise, D., Shubhangi Lakde and Shankaranarayanan, K. 2013. High density planting system in cotton - The Brazil Experience and Indian Initiatives. Cotton Res. J. 5(2): 172- 185.

About the authors:

Andrew Paul Gutierrez FRES is Senior Emeritus Professor in the College of Natural Resources at the University of California at Berkeley. He was founder of the

University of California Integrated Pest Management Program and Associate Director of the National NSF/EPA/USDA IPM Projects. He has 40years of experience working on cotton globally. He is CEO of the Center for the Analysis of Sustainable Agricultural systems (CasasGlobal.org) with ongoing research programs globally on various crop systems.

Hans R. Herren received the World Food Prize (and others awards) for his leadership of the hugely successful project on the biological control of cassava pests in sub Saharan Africa; he is President of the Millennium Institute, Washington DC (USA) and of the NGO Biovision, Zurich, Switzerland and a Foreign Associate of the US National Academy of Sciences. He has global experience in diverse agricultural systems.

Peter E. Kenmore is a MacArthur Fellow (Genius Award) for his work on IPM in green revolution rice, former head of FAO/Plant Protection, and former FAO Ambassador to India. Kenmore was the founder of the internationally renown Farmer Field School program in Asia.