GMO Bt COTTON HAS FAILED

TRANSITION TO CLIMATE RESILIENT AGROECOLOGY IS THE IMPERATIVE
For India's present & future Biosecurity

Bt COTTON: *Never was a technology promoted like Bt cotton with the seed presented as a "magic bean", the ultimate agri-utopian-bean of NO INSECTS AND HIGH YIELD. Irresistible! (AR)*

Summary

Over the years, there have been competing narratives on Bt cotton in India. There are those who claim it has been a great success, while others argue that the technology has failed. The government itself is using the success narrative as a template to push a wide range of GM food crops into India's fields. However, it is time to set the record straight.

Bt cotton was officially commercialised in India in 2002 to legalise illegal Bt cotton. Prior to 2002, extensive use of insecticides to cope with the Pink Bollworm (PBW), which is native to India, caused ecological disruption, inducing the American Bollworm (ABW), which is a secondary pest. The damage from ABW is considerably greater than that of PBW. The ABW became the target for Bt cotton.

Although Bt cotton is supposed to control both species of bollworm, the PBW is now resistant to even stacked Bt toxins, and the ABW is also developing resistance. Moreover, post 2002, with resistance to Bt and insecticides developing, new induced pests are also appearing (whitefly, jassids, mealybugs, etc), causing crop failures. This is the classic pesticide biotech treadmill.

The one-sided official Bt cotton success narrative is seriously wrong. It attempts to disguise the fact that Bt cotton benefited from a range of factors, including increased fertiliser use, hybrid trait yield (which is not attributable to the Bt technology), better irrigation and extra attention given to Bt cotton cultivation by farmers who had invested much in expensive Bt cotton seeds. The implications of irresponsibly rolling out other GM crops based on this misleading narrative will be disastrous for farmers, food safety, and the biosecurity of India.

Background: We address this press conference in the backdrop of erroneous official claims including by the Union of India in submissions to the Supreme Court of India, Agri Ministers in Parliament, that Bt cotton is an *"outstanding success"*. Some public-sector scientists have joined this chorus. However, wrong data is cited in support of this statement, e.g., total national cotton production data, as opposed to kg /Ha; the latter is the proper statistic for true performance i.e. YIELD. Based on such flawed conclusions, the added and dangerous formal position of the Regulators / Government is that therefore, the *experience and success* of Bt cotton must be 'replicated' in India's food crops, including Bt brinjal, Bt rice, Bt okra and an infinite number of other Bt food crops – a full -scale entry of GMOs into Indian agri.

The time has come to set the record straight; the consequences of flawed conclusions based on a flawed understanding of the problems in cotton, and we are constrained to add, the intentional use of the wrong data, will be catastrophic for India. Why do we face such a situation is the Question? The fact also is that there is straightforwardly, a plainly obvious official agenda to promote GMOs in Indian agriculture, without scientifically documenting the need. We cannot of course, address an agenda of the Government and its Regulators.

Bt cotton – facts and data that affect the analyses: Many agri issues go into a pot-boiler and they are complex, when dealing with the performance/analyses of Bt cotton. Primary, is the whole issue

of development of INSECT RESISTANCE, induced pests & resurgence, bad decisions, increase in insecticide use, serious attendant problems of crop failures as a result of secondary pests, and the seriously escalating costs of hybrid Bt farming, all of which finally translate into the outcome on the ground – YIELD. All contribute to a picture that the Bt cotton experiment has gone very wrong. The socio-economic impacts have never been really addressed. We are darkly confronted with the evidence of several thousands of farmer suicides among Bt cotton farmers, and in data that correlate the two (e.g., Gutierrez, Kranthi, Kannuri & Jadhav [1]). In 2016, the Central Government admitted to several of these facts in the High Court of Delhi, accepting that insect resistance to insecticides and Bt toxin(s) had set in, leading to decreasing yields and crop failures. SIMPLY PUT, Bt COTTON HAS FAILED. We present the main issues with a focus on YIELD, after 16 years of Bt cotton. Graphs, Data/compilations are based on official data/CICR/Cotton scientists etc.

(a) Bt toxins in Indian cotton, specifically control for two main species of bollworms (BW) that attack cotton: the American BW (ABW) and the Pink Bollworm (PBW). The objective was to 'protect' performance and decrease insecticide use. Both objectives have failed. Bt toxins are not toxic to sap-sucking insect species such as jassids, aphids, whiteflies, thrips, mealybugs, mirid bugs etc., that under ecological disruption by insecticides can greatly damage the cotton crop.

(b) Bollworms and resistance: The Pink Boll Worm (PBW) is native to India and has always been a problem in long season cotton, and was the target of insecticide use prior to 2002. The so called American bollworm (ABW) is a secondary pest that was induced by extensive insecticide use and became the target for Bt cotton ([2]). Different species, similar to ABW, have been induced in different parts of the world by pesticides that kill their natural enemies, creating a 'control' vacuum releasing species like ABW with very high reproduction potential for damage (Fig.1), (a ABM female can lay 700-850 eggs in a week). Furthermore, the damage the feeding of American bollworm larvae cause is considerably greater than that of PBW. **Bt cotton controls both of these species, unless resistance to Bt toxin occurs, as has happened in Indian cotton -- especially in pink bollworm.** Resistance in PBW now occurs to both Monsanto's Bollgard I and Bollgard II Bt cotton (BGI and BG II). BGI (1 Cry toxin) was replaced by BG II (2 cry toxins – Cry 1Ac+Cry2Ab) as early as 2007--8, a bare 6 years after its introduction in 2002 because the PBW had developed resistance. The ABW is also now developing resistance to stacked Bt toxins in BG II.

This is the classic pesticide, and now biotech treadmill. If you spray you create a vacuum because just about everything is killed for a short period, but because of the high migratory capacity and high reproductive potential of ABW (6 to 7 fold of PBW), ABW populations explode (see Fig. 1). Pink bollworm, which has fewer effective natural enemies, would also increase. *"This scenario has occurred world-wide in cotton, and Bt cotton brought only temporary relief in India"* (Gutierrez). **Post 2002, with the introduction of Bt cotton, with resistance to Bt and insecticides developing, new induced pests are appearing for the same reason (whitefly, jassids, mealybugs etc).**

In summary, you spray for pink bollworm and you cause outbreaks of American bollworm, causing ecological disruption -- farmers spend money to lose money (Kranthi/Gutierrez – see footnote 2).

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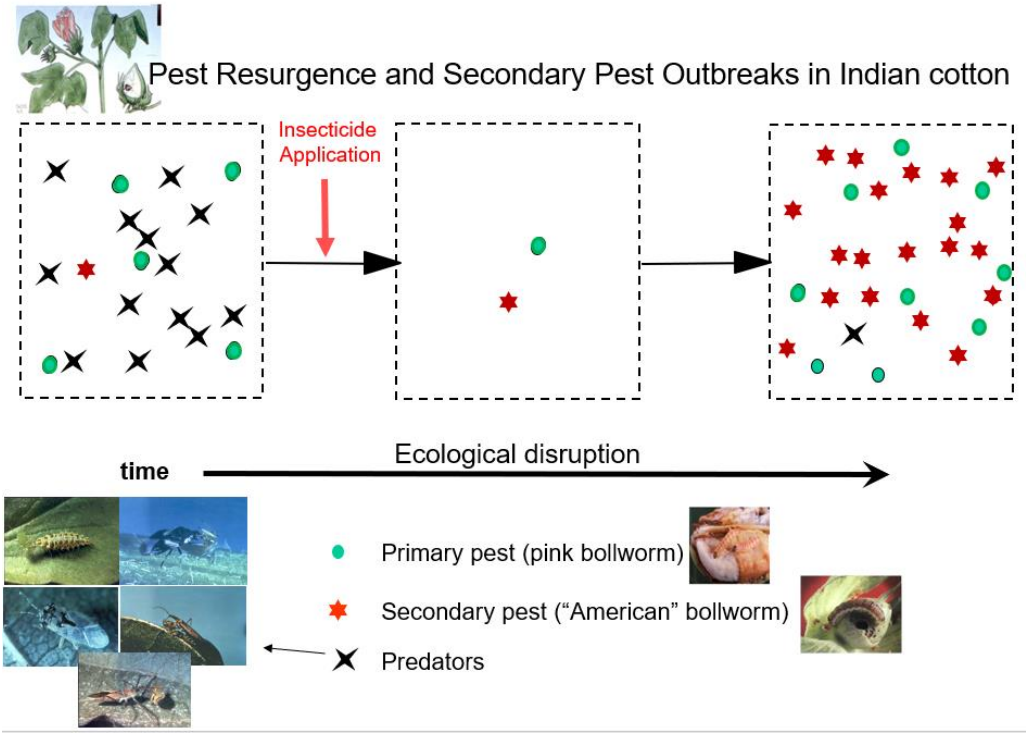
[1] Gutierrez AP, Ponti L, Herren HR, Baumgärtner J, Kenmore PE. 2015 Deconstructing Indian cotton: weather, yields, and suicides. *Environ. Sci. Eur.* **27**, 12. (doi:10.1186/s12302-015-0043-8)
Kranthi 2017: various CAI newsletters
Kannuri NK, Jadhav S. 2018 Generating toxic landscapes: impact on well-being of cotton farmers in Telangana, India. *Anthropol. Med.* **25**, 121–140. (doi:10.1080/13648470.2017.1317398)

FIgure 1 --Ecological Disruption pre-Bt cotton -- (introduced 2002)



(c) Hybrid Bt cotton: Bt technology has no trait for yield. In India, however, Bt was engineered into American hand pollinated hybrid cotton varieties, the only country in the world to do so. WHY?? Other than India, no other *Bt*-cotton adopting country including China, USA, Brazil, Australia, Mexico and Burkina Faso credit *Bt*-cotton with yield enhancement. But hybrid Bt cotton was a double bonanza for the developers: **first**, it allowed a smudging of the yield data. Isolating hybrid yield would prove to be difficult in the short-term, (precisely the situation we face, a handy tool of disinformation); **second**, it provided a '*value-capture'* mechanism for Monsanto, because millions of small farmers cannot be controlled by threats of lawsuits, as occurs in industrial agriculture in the US/developed countries. The introduction of these hybrids occurs at the total expense of our farmers, as it disallows saving seed, forcing farmers to buy new (expensive hybrid) Bt cotton seed each year. Hybridisation gives one-time vigour. Why was predatory technology allowed by the Regulators?

i. **Phenomenal increase in labour costs due to hybrid cultivation:** The labour requirement in hybrid cotton is significantly higher as compared to varieties due to the additional processes required in hybrid cotton fields. Hybrids are input intensive and are sown at suboptimal wide spacing of 90 x 60 cm or wider, and because they are long season cottons they are more susceptible to pest build-up, require more human labour for sowing, weeding, spraying, fertiliser applications and harvesting.
ii. **Hybrid Bt cotton also requires more water, i.e. irrigated conditions**. 66% of cotton in India is rain-fed, and a myriad of over 1100 Bt hybrid varieties of variable quality were planted on 92% of the cotton area. "---if there is one single message that Indian breeders, agronomists and plant protection specialists need to take seriously, it is "-***India needs to design its crop***

duration as per the monsoon and soils" *--- Majority of the Bt-hybrids are susceptible to sap-sucking insects such as whiteflies, mealybugs, jassids, etc --- and susceptible to diseases such as cotton leaf curl virus disease, leaf streak virus, etc., and are serving as hot-spots by supporting pest and disease populations. Cotton leaf curl virus disease and whiteflies are re-emerging as major problems in North India due to the indiscriminate release of susceptible hybrids. Insecticide usage is increasing each year because of resistance development in sucking pests to imidacloprid and other neonicotinoid insecticides—by 2012 insecticide usage was at 2002 levels and will continue to increase inducing further outbreaks of insecticide and Bt resistant pests. ---- While the 'Bt-cotton-resistant' PBWs are causing severe economic losses to Bt-cotton, the American bollworm is also developing resistance to Bt-cotton, thus leading to unsustainability of the technology"* (Kranthi 2017).

Note: Probably due to the high seed costs of *Bt*-cotton hybrids, coupled with high expectations, cotton farmers across the country invested more on all the production processes including timely deployment of human labour to ensure a better *Bt*-cotton hybrid crop. They lavished expensive GM seeds with care and attention (Gilbert, 2013). Kathage and Qaim (2012) reported that Bt fields received 23-26% more irrigation, 13-25% more fertiliser, and 11-18% more labour.

(iii) Seed Costs/Cost of cultivation (Kranthi[2]: At introduction in 2002, an equivalent packet of Bt cotton seed was more than 2000% higher than non-Bt varietal seed. Monsanto was allowed a 'royalty' on Bollgard I seed without having a patent on it. Conservative estimates show that on average, the additional expenditure on seeds was at least **Rs. 1179 per hectare** and the Indian farmer may have spent a **total additional amount of Rs 14,000 crores on *Bt*-cotton seeds** during the 17-year period from 2002 to 2018. The trait value charged (2002-2018) is around Rs 7,000 Crores. This excludes Royalties accruing to Mahyco- Monsanto, which were illegal on Bollgard I (first generation Bt cotton), and yet allowed by the regulators.

(d) Net profit (ref. Kranthi -see footnote 2) was Rs. 5971/ha in 2003 (pre-Bt), but plummeted to net losses of Rs. 6286 in 2015.

(e) Fertiliser use Kg/Ha: a 2.2 fold increase has *"contributed more to yields than bollworm protection by Bt-cotton"* (Kranthi KR. 2016)[3]. **Figure 2** below illustrates the effect of increased fertiliser use on yield (up to the current low yield stagnation level).

The increasing costs of the Bt cotton technology adoption are summarized in **Figure 3**

[2] **Kranthi**: cost of cultivation/production/related data: source: M Of Agriculture, Govt. of India: https://eands.dacnet.nic.in/Cost_of_Cultivation.htm Cost of cultivation /

[3] **Kranthi**: '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.pdfKranthi).

Figure 2. The effects of increased fertilisation on yield

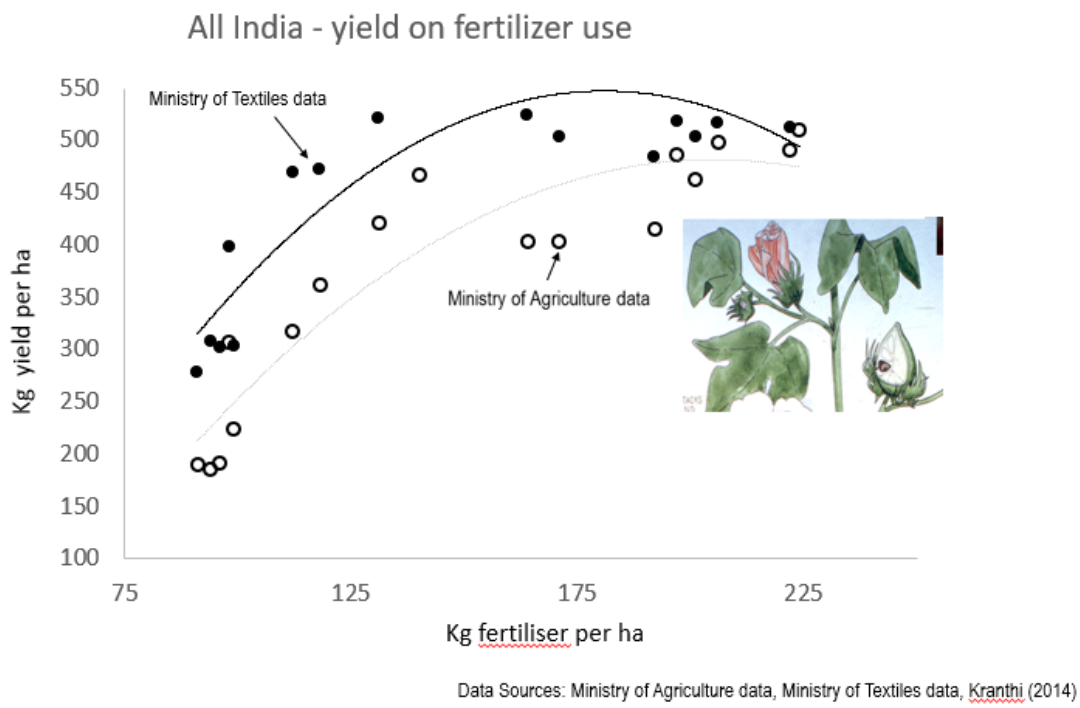


Figure 3: The cost of Bt cotton technology

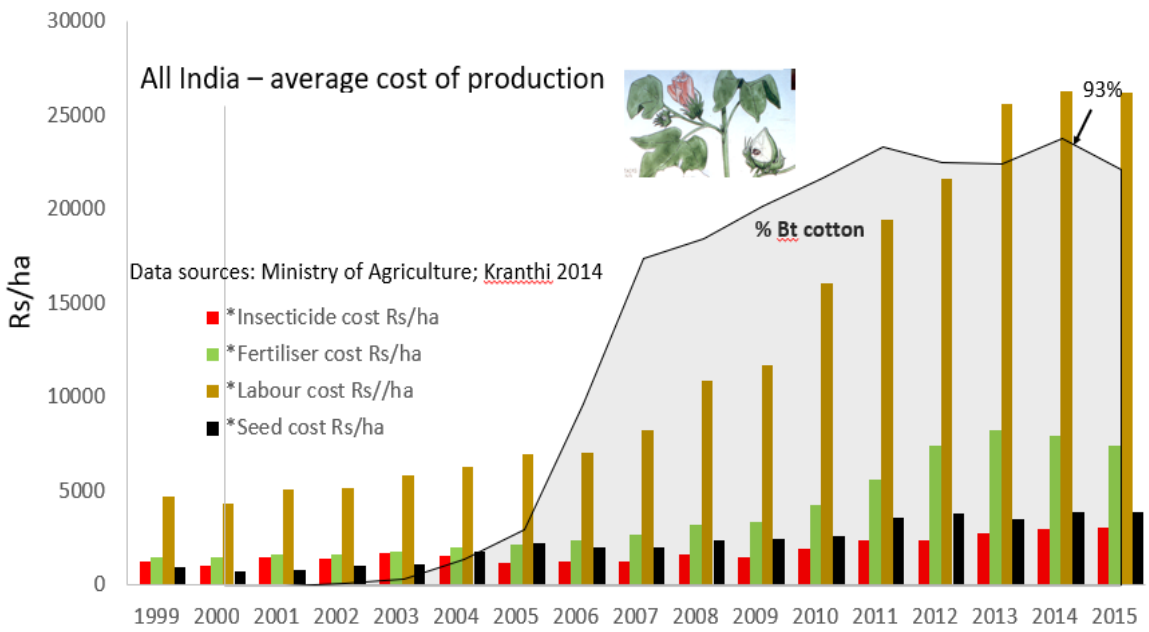


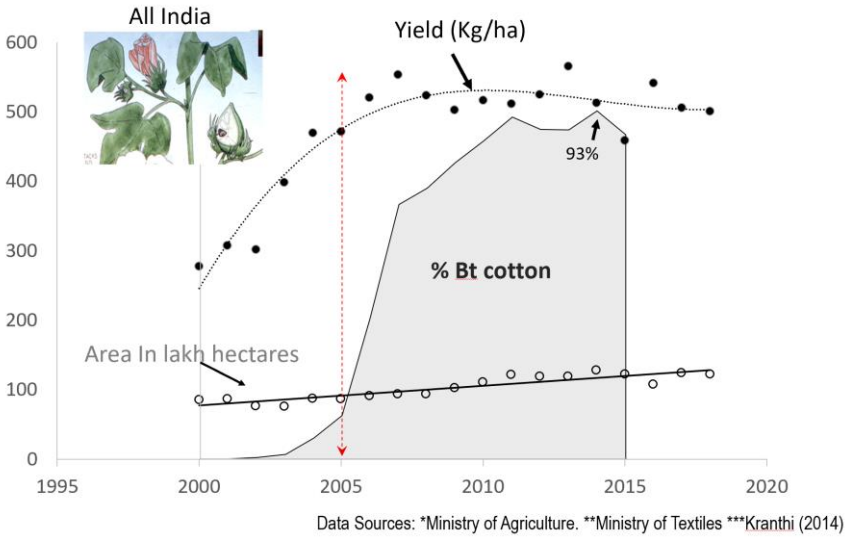
Figure. 3. As the Bt technology was being implemented, costs of production were increasing, with labour cost showing the greatest increase. And these **costs were increasing in the face of stagnant yields (see below)** (highest yields which are of the Ministry of Textiles (●) are used).

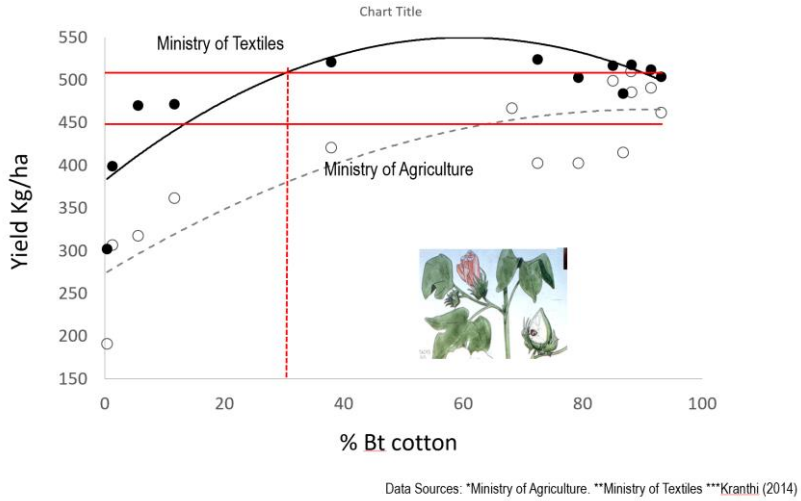
ALL INDIA AVG. YIELD: KG/HA: Includes irrigated and rain-fed cotton: Average All-India Bt cotton yields have stagnated, hovering at around/below **500 Kg/ha over the 14 years of 2005 to 2018**, despite the use of ONLY HYBRIDS in Bt cotton, which is around 90% of sown cotton. Some zonal data are no more than even the poorest of African countries, which do not cultivate either Bt-cotton or hybrid cotton. In 2017, 31 Countries were ranked above India in terms of cotton yield and of these, only 10 grew GM cotton. [4]

- **FIGURE(S) 4 PUTS TO REST THE LIE THAT BT COTTON WAS RESPONSIBLE FOR THE MODEST INCREASES IN COTTON YIELD.**

In 2005 and 2006, Bt cotton adoption was ONLY **about 12 and 38% respectively (Figs. 4 below),** and yet average yields had reached the current low yield plateau of about 450-500 Kg/Ha (CAB and DES data). Bt cotton was not responsible for the increase; but increased fertiliser was (Fig. 2).

Figures 4. Yield of cotton since 2000 viewed against increased Bt cotton adoption





[4] **In 2014-15,** India's National average yield was 510 kg per hectare compared to the 'rest of the world's average yield of 931 kg per hectare. The yields in a few countries were 1500 to 2600 kg lint per hectare which is 3 to 5 times higher than India. A few years ago, yields in these countries were also at 500 kg lint per hectare. But, these countries used simple technologies to enhance yields progressively over the past two decades.

THE IMPERATIVE OF CLIMATE RESILIENT (CR) AGROECOLOGY

The just released global scientific review[5] (February 2019), reveals that greatly plummeting insects' numbers may lead to extinction of 40% of the insect population over the next few decades, threatening a global collapse of ecosystems. The main drivers include **industrial scale, intensive agriculture and the reliance on pesticides and fertilisers[6].** 50% greenhouse gases contributing to climate change are from the industrial food and agriculture system (Vandana Shiva)[7].

GMOs push the same drivers. They encourage 'industrial agriculture', and chemical farming, both of which are entirely inconsistent with organic/agroecology. The only beneficiaries would be multinational GMO seed and herbicide conglomerates. GMOs have also *"become the gateway to controlling seed germplasm"* (as is the case of Bt cotton in India), and this is threatening the genetic diversity of crops, for the additional reason that GMOs lead to certain contamination of Non-GMOs and cannot coexist.

Agroecology: On the other hand, there is international consensus that the solution to food and nutritional security is through agro-ecological sustainable models of agriculture. *Non-GMOs, traditional plant breeding, & newer methods,* (including evolutionary breeding) *continue to outperform GE hands down, in all regions, at much less cost per trait* (Gurian-Sherman: 'Failure to Yield'). Pointedly, **GMOs are not needed.**

It is now also known that agro-ecological systems of farming, preserving forests and with agro-forestry, will help the very urgent work required **in the now reduced 1.5°Celsius pathways**, to sequester carbon by natural means, by removing CO2 from the atmosphere, a key objective to mitigate climate change.

Climate Resilient (CR) agroecological farming is a well-established international and scientific paradigm of agriculture[8] that protects nature, farmers and peoples for all times and its foundations are in India. *'An Agricultural Testament',* the classic written by Albert Howard in 1940 acknowledges this fact. Indian peasants have been *the Professors* spreading Agroecology globally.

- The near 40 year 'Rodale Farming Systems Trial'[9] shows organic systems produce up to 40% higher yield in times of drought, release 40% fewer carbon emissions, earn 3-6x greater profits for farmers, are competitive with conventional yields (after a 5 year transition), leach no toxic chemicals. The ability of agroecology to double food production within 10 years was re-affirmed by the U.N. Special Rapporteur on the Right to Food. Regenerative Organic farming can draw down excess carbon from the atmosphere and put it in the soil, reversing climate change, and making agriculture climate resilient (Vandana Shiva, Andre Leu).[10]
- Underscoring such diverse findings from multiple sources, "m*ore than 70 percent of the food consumed in developing countries"* (the FAO puts this figure at 80%), *"where hunger is*

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[5].https://www.sciencedirect.com/science/article/abs/pii/S0006320718313636

[6] Re multiple ecological disasters being driven by chemical farming , references are in: https://navdanyainternational.org/cause/poison-free-food-and-farming-2030/

[7] **V Shiva**: Soil Not Oil , Women Unlimited , Delhi ,2008

[8] **IAASTD:** The International Assessment of Agricultural Knowledge, Science and Technology for Development, 2008), to which India is a signatory, / UN, FAO, WWI (World Watch Institute etc.

[9] '**Rodale Institute Trial'** started in 1981: https://rodaleinstitute.org/science/farming-systems-trial/ ;the longest-running 40 year side-by side comparison of organic and conventional cropping systems in North America.

[10] Biodiversity, Agroecology , Regenerative Organic Agriculture' , Westview , New Delhi 2018)

pervasive, is grown in those countries, the majority of it by small-scale farmers. Those farmers are the main people doing ***the feeding now.*** *And they're only using 30 percent of agricultural resources to do it. (That means industrial agriculture is using 70 percent of the resources to feed 30 percent of the population.)"* (Timothy A Wise[11]). And the evidence for agroecology to show full potential to deliver sustainable food systems comes from 3 studies in Brazil, Senegal and India.[12]. Navdanya's work over 3 decades also shows that we can produce enough nutrition for two times India's population through biodiversity-based Agroecology[13]. Agroecological farming can increase farmers' incomes ten-fold compared to chemical monoculture for commodity production, (ref. Vandana Shiva, Vaibhav Singh)[14].

Organic, non-chemical and Non-GMO farming, is the fastest growing segment in the world, and plays right into India's natural competitive advantage in its organic small-holder farming systems, a historical gift of knowledge to our Nation. 'Desi' species of cotton varieties (*Gossypium arboretum*) are highly amenable to organic farming **and have not been contaminated by hybrid American cotton, being a different species.** The new long staple Desi varieties provide an excellent opportunity for India to emerge as a global leader in organic cotton to produce high yields of long staple fibre at very low production cost based on organic farming systems. (Kranthi)[15] **This can provide a sturdy roadmap for sustainability especially in small-scale farming systems**. Therefore, the solutions to Indian cotton are known within the CICR – **solutions that could double yields. These cottons are not GMO or Bt hybrids.** Why are they not being implemented as a priority national policy, instead of the disinformation that continues to be trumpeted by vested interests? India is today, the world leader in global cotton production contributing 51% of the global production, but even this position is being eroded, down from 80% in 2009.

- The focus on farmers in agroecological farming systems, which is based on farmers' seed sovereignty, is a demonstrated viable alternative and moral imperative to the corporate focus on intellectual property rights, to **genotypes**. India should not succumb to GMOs and the single-minded, narrow production strategies of profit- driven multinational/biotech corporations. **Sustainable and climate resilient agroecology based on sound science is the solution to the agrarian crisis and farmers' distress.**

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(Lead Petitioner – SC - GMO PIL)

Director, Research Foundation for Science, Technology and Ecology

Date: 6 September 2019

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[11] Timothy A Wise: "Eating Tomorrow: Agribusiness, Family Farmers, and the Battle for the Future of Food".

[12] *M. Jahi Chappell and Annelie Bernhart et al. Misereor October 2018 https://www.misereor.org/fileadmin//user_upload/misereor_org/Publications/englisch/synthesis-report-agroecology.pdf*

[13] Ref: Health per Acre, https://www.navdanya.org/attachments/Health%20Per%20Acre.pdf

[14] 'Wealth Per Acre,' Natraj, Delhi 2015.

[15] Keshav R Kranthi: Global best Practices for Doubling Indian cotton farmers' Income': *This report contains text reproduced from articles written by Dr Kranthi in the CAI Newsletter 'Cotton Statistics and News' published by the Cotton Association of India.(2017)*