Sustainable Agriculture, Biotechnology, Rural Development

Is a convergence possible?

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For the National Seminar on Land Use Planning for Biodiversity Conservation, Thrissur, Kerala, August 6-7, 2009

The theme of ***Sustainable Agriculture, Biotechnology and Rural Development*** combines three different strands which together weave an intricate fabric of "development" in the contemporary Indian socio-economic-political scenario. To untangle them in order to understand what they represent "separately and together" is a complex task.

Before discussing their relationship, each of these terms viz., sustainability, agriculture, biotechnology and development, must be subjected to a clear re definition. This task will help us arrive at a set of *out of the box* definitions that are quite different from the business-as-usual characterisation that emanates from visionless establishments, scientific or otherwise.

Take for eg. the term sustainability. Usually sustainability is measured from a monetised point of view causing it to lose all its deeper and profound meaning. Only when we demonetise the term and start looking at it from the perspective of human and ecological well being, only then that we can arrive at a fresh understanding of sustainability, the way the word was meant to be understood. In other words, if we mean by the word sustainability, a phenomenon that can sustain human ecology instead of human bank balances then the term acquires an insightful meaning.

We must use this context to examine the relationship between "biodiversity" an element intricately connected to sustainability in agriculture and "poverty" measured in monetary terms. Can we pause to think why is it that biodiversity rich Southern countries are called poor and biodiversity poor North is supposed to be rich?

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Contrast it to the fact that hubs of biotehcnology lie in *biodiversity- poor* countries. It is also a fact that the hegemonical global order that supports biotechnological products politically through the WTO regime and legally through an IPR regime while biodiversity is declared the common inheritance of mankind! This kind of political framework cannot be avoided in our discourse on biotechnology and rural development.

Global experiences have clearly demonstrated that biotechnology based agricultural development can be extraordinarily enervating when measured in terms of natural, cultural and social parameters that govern humankind. [the felling of Amazonian jungles to cultivate GE soy, monoculturing of Argentina, the serial suicides of Indian farmers in the Bt cotton belt of Vidarbha are some of the examples] Biodiversity based agriculture on the other hand has given multiple evidences that it can enhance human and environmental wellbeing. But still the policy paradigm in India looks at biotechnology as

the silver bullet that can dissolve the poverty of rural India. This is mirrored in the clever slogan coined by the biotech industry: ***IT is India Today, BT is Bharat Tomorrow.***

In the backdrop of these assumptions that rule our discourses, I would like to argue that commercialised, individual and corporate profit driven science should not be our standard of measure while evaluating the significance of sustainable agriculture and its relationship with biotechnology and rural development

Sustainable Agriculture, what is it?

Let us start with the Green Promise of the Green Revolution. I know that it is tiring to revert to this worn-out old issue. But question we must of the promise that assured us that the country will never go hungry again. Fifty years on, are we sure that this promise will be forever? In the meanwhile, to fulfill this promise our focus was shifted from biodiversity to theories of single grain yield, from land races to HYVs and together they heralded an intensive farming system that uses colossal amounts of fossil fuel based energy systems. It might be interesting for us to look back and draw an energy balance sheet of this system of farming. It is also important for us to debate whose agenda did this model of farming addressed, who gained in the short term and who lost in the long term.

It might be a sobering thought to count things that we have lost during this period. From an awesome wealth of over 100,000 varieties of rice that India cultivated at the beginning of the last century, we have been reduced to using less than 5000-10000 varieties, a destruction of about 90-95% of that wealth. Millet farming that embodied our biodiversity, has been shrunk by more than 35% [from 46 mln Ha in 1970 to less than 30 mln Ha in just over 30 years.

Since India is home to small and marginal farmers, it becomes critical for us to examine the element of control while discussing sustainable agriculture. Questions such as "who are we farming for? Is it our control or an external control and whose inputs are we using" in our farming form the soul of sustainable agriculture.

Arguments against India's traditional biodiverse and ecological farming systems are that they were low yielding, farmers are not knowledgeable people and their farming is "unscientific". If this was true why is it that so many farmers [their numbers run into hundreds of millions] still practice such non chemical, ecological and biodiverse farming? A principle that underlies all these farmers is that they value their own control over their farming. And that they grow primarily for their families since they treasure the importance of good food. They also have a special relationship with earth whom they treat as Mother Earth. They see their agriculture as tending the earth rather than mining it. All these are fairly old arguments. But since the term sustainability has gained new ground in our discussions, the argument of "yield" needs to be reexamined.

While the traditionally practiced agriculture was junked by the Green Revolution Science calling it low yielder, historical evidences tell us something else. The Coorg province [currently Kodagu region of Karnataka], it is recorded, grew 50,000 lbs [about 9 tonnes]

of rice per ha according to a treatise published in 1945. Dr Richaria a brilliant scientist who made phenomenal contribution to Indian agricultural science in the '60s spent a life time discovering and characterising rice varieties in Central India. His records point to a dozen or more varieties of upland rice that produced upto 8.5 to 9 tonnes per hectare. Even today, farmers in the Garhwal region of Uttarakhand produce upto 7.2 tonnes per hectare under traditional irrigation practices that use between 30-40% less water than the conventional canal irrigation systems. Compared to the current average productivity of 2.3 tonnes/ha in India, the traditional varieties are a marvel by themselves. Considering the fact that they were grown under totally ecological conditions, they offer clear sign posts to a sustainable agricultural future.

It might be interesting to contrast these levels of production to the productivity of HYV rice in Kerala. In 200-2001, with nearly 70% of the farms under HYV, Kerala was achieving just about 2.2 tonnes/ha. [Source: Directorate of Economics and Statistics, 2001; Kerala State Planning Board, 2001, 2003]

In Punjab, the Gateway to Green Revolution, I did an interesting exercise in 2008 in the village Chaina in Bhatinda District with a group of about 20 farmers. We sat down in a wheat field and together, through PRA methods compared the returns from two farmers at different times in history. One was the farm of Mr Ram Singh, aged about 70 and the other was Mr Gora Singh, aged about 30. The figures that Mr Ram Singh quotes are about fifty year old while Mr Gora Singh's figures are contemporary. Economists who were present with me in that PRA exercise told me that Rs.1000 in 1955 was worth Rs.100,000 today [they took the land prices as an indicator]. Thus it could be concluded that by using purely ecological means a farmer earned ten times more than the Green Revolution model of farming. [See Box]

BOX 1. PRA at Chaina village, Bhatinda District, Jan 21, 2008

Ram Singh's holding : 12 acres **Gora Singh: 5 acres.**

Activity	What was used by Ram Singh	What was used by Gora Singh
• Ploughing	Bullocks, desi, own	Tractor
• Seed	Own, desi	Hybrid [bought]
• Water	Half irrigated by canal; half rainfed	Half irrigated, half borewell
• Implements	Wooden, made in the village	Tractor related; from outside
• Labour	All family	Hired; fly does not work
• Supervision	Visit daily to farm	Ten days a month; no farm round
• Animals	Two bullocks, one cow, one goat; grazed in the farm	One bullock to bring fodder home; grazes at home
• Fertilisers	Home made; FYM	Chemical; :Urea; Potash; DAP; Zinc
• Weedicides	None; no weeds	Yes
• Income	40 *mann*/per acre worth Rs.1000 [No costs at all]	Rs.25000/acre [before cost deduction] and after costs, about Rs.10000/acre

Apart from these purely yield related statistics, there are many other traits that are common to People's farming when compared to the Institutional Farming. Prominent among them were:

- Very low or no external inputs
- Ecological methods of farming
- Perfect energy balance sheet
- Assured community level food sovereignty
- Indigenous knowledge base

Of these traits, all of which I find fascinating, the trait of Community Food Sovereignty is the most critical since it holds the key to sustainable agriculture. The foundation of this trait is the indigenous knowledge system that governed and nurtured sustainable agriculture. The indigenous knowledge is an authentic knowledge production system: holistic, scientific and modern. It makes farming truly knowledge based as against the current paradigm of information based farming This brings a completely new dimension to our understanding of both science and sustainable farming. The critical difference between the two systems is that all the knowledge surrounding agriculture was located within the community which made it possible for them to farm sustainably. As against this, the current market based [for seeds, fertilizers and pesticides] agriculture keeps all the knowledge centralized and outside of the communities thereby making it a totally alien system. Listen to what the largest global meet on food sovereignty held at Nyelini, Mali, West Africa in 2009, said in its final declaration:

> *We are fighting for a world where we are able to conserve and rehabilitate rural environments, fish populations, landscapes and food traditions based on ecologically sustainable management of land, soils, water, seas, seeds, livestock and all other biodiversity;*

This is the essence of the principle of sustainable agriculture. If we are to achieve this ideal, we need to rely more and more on people's science rather than on institutionalised agricultural science that appears incapable of embracing the enormous complexity of the indigenous science. The complex Aztec systems of Mexico, one of the shining examples of indigenous farming, recognises more than 24 soil types based on the *source of their origin, their color, texture, smell, consistency, and organic content*. Further Aztecs ranked these soils according to their agricultural potential. They were also adept at soil amendments.

From the distant Aztecs if we move to the neighbourhood home gardens of Kerala we still can witness the same principle of complexity. In their homesteads, Kerala's women and men grew a complex array of trees, vines, creepers, climbers, fruits, spices, vegetables and crops until the invention of the Rubber Board which stamped rubber on all these systems and monocultured many minds. This is said to have irrevocably destroyed many home garden systems and heralded farmer suicides [which stood at a total of 11,516 between 1997-2005] and the creation of a food deficit Kerala. [According to Government figures, Kerala's total foodgrain requirement is 48 lakh tonnes a year and internal production accounts for only 10 lakh tonnes.]

A comparable system that has remained sustainable and resilient is the Kandyan Home Garden system in Sri Lanka. A 1992 estimate by an FAO study estimated in monetary terms this amazing system and put its net income at about Rs.5200 per acre*[The Forest-garden farms of kandy, Sri Lanka*, FAO, Rome 1992]. At current prices this could easily be about Rs.50,000/acre. This is an amazing figure by itself. However if we are able to look beyond this financial calculation, the Kandyan Home Gardens, similar to the Kerala Homesteads, gave their owners food, fruit, fodder, fiber, spice, medicine, greens and vegetables, health and nutrition besides valuable timber when needed. Thus it created a microcosm of household food sovereignty.

In a completely different climatic space, in the semi arid region of deccan as well as the mid mountain ranges of the Himalayas millet farming systems continue to serve the same purpose even today, in spite of their systematic elimination by successive policy regimes. The *Baranaja* systems of the Garhwal, *Saat Dhan* in Rajasthan and the *Pannendu Pantalu* farming of the Deccan grow millets in combination with pulses and oilseeds making it a completely holistic farming system. A unique phenomenon of this system is that it hosts a unique food system called uncultivated foods. The uncultivated foods are also present in the home gardens across the Western and Eastern Ghats as well as the East Indian states. They are characterized by their unique utilization of space [vertical ad horizontal], complex designs, hedges as hosts of a variety of food and medicinal plants and high productivity.

The uncultivated food plants are variously described as wild harvests, voluntary plants etc. The short sighted modern agriculture system calls them as weeds since it cannot understand nature's own initiatives in enhancing human food basket. Uncultivated foods are highly rich in nutrition and are used as medicinal plants by scores of rural communities even today. Besides they are one of the finest cushions for human food during the periods of stress and famine. When the cultivated foods decrease during such periods, the uncultivated foods increase, thereby keeping the food availability in balance.

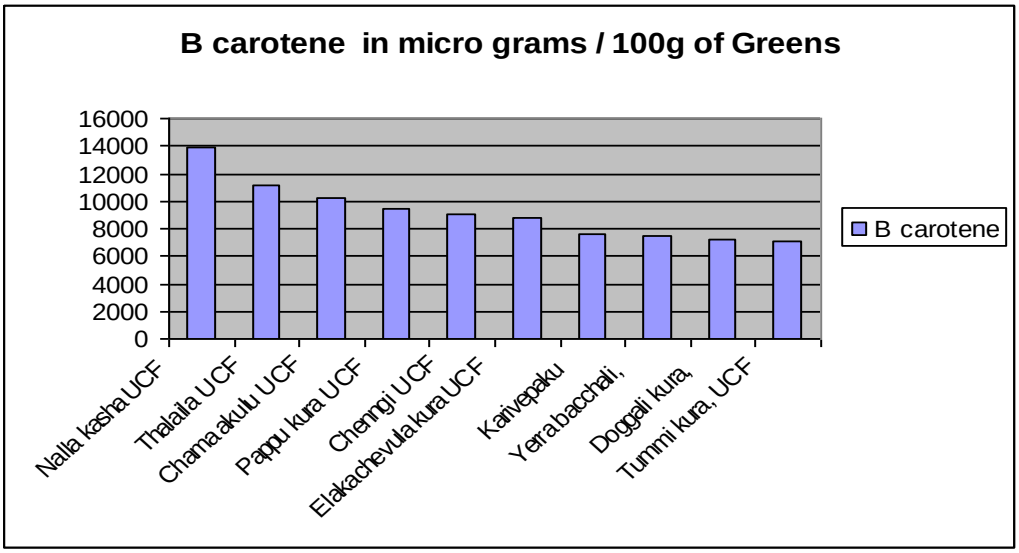
These greens are sources of many nutrients, which are essential for growth and maintenance of normal health. Most of them are rich sources of calcium, iron, carotene, vitamin C, riboflavin and folic acid. [**see box 2].** Any comparison between uncultivated greens and cultivated greens leaves the cultivated greens far behind in the race. In a list of six nutritive values ranging from Fiber to Calcium to Vitamin C to Beta Carotene, no cultivated greens finds a spot in the first ten places. Under each of these parameters, the topmost places are occupied by the uncultivated greens. The market favoured cultivated greens such as spinach, fenugreek and cabbage occupy miserable places at the bottom of the table. With their high content of Iron, Calcium and Protein, they are a boon to pregnant and nursing women as well as young children. While the large ICDS networks in the country struggle to meet what they call the iron deficiency among pregnant women, those rural women who consume uncultivated greens on a regular basis, rid themselves of this deficiency with no extra effort at all. Similarly the abnormal levels of malnutrition in the country can be abolished if our food and farming system starts focusing on the uncultivated greens.

Box 2: Uncultivated Foods : Storehouses of nutrients

	Local Name	Fiber G	Calcium G	Phosphorous G	Iron MG	B carotene Micro grams	Vitamin C MG
1.	Thalaila UCF	3.5	2245	235	212.9	11183	106.23
2.	Jonnachenchali UCF	8.8	3237	154	111.3	6438	127.42
3.	Elakachevula Koora UCF	5.4	1350	166	97	8787	163.96
4.	Tummi Koora, UCF	4.5	719	46	81.6	7020	174.96
5.	Pappu Koora UCF	4.2	767	91	59.4	9404	1045.52
6.	Yennadri UCF	1.9	243	44	17	4165	123.6
7.	Bankanti Koora UCF	2.8	366	77	15.4	7019	151.2
8.	Thengedu Puvvu UCF	3.7	167	42	12.7	1940	968.56
9.	Uthareni UCF	3.3	417	68	12.5	5311	94.56
10.	Chennangi UCF	3.3	882	125	10.7	9029	260.85
11.	Thota koora	1	397	83	3.5	5520	99
12.	Gongoora		172	40	2.3	2898	20
13.	Menthikoora	1.1	395	51	1.93	2340	52
14.	Palakoora	0.6	73	21	1.14	5580	28
15.	Gobi gadda	1	39	44	0.8	120	23
16.	Chukka koora	0.6	63	17	0.8	3660	12

Study: Deccan Development Society and National Institute of Nutrition, 2002

Similar is the case with micro nutrients. While the urban, non-food producing populations run for the micronutrient cover to protect their health by purchasing capsules such as *Spirulina* [a Beta Carotene source] from pharmacies, the rural ecological food producers derive them in plenty from scores of "wild weeds" [see **Box 3]**.



Study: Deccan Development Society and National Institute of Nutrition, 2002

Since they come at no monetary cost at all, for the poor they are a boon from the heaven. In a manner of speaking, this is the triumph of the 'poor" ecological farmers over the rich and deficient.

As mentioned in an earlier paragraph, the distinctive aspect of all these manifestations of sustainable agriculture is the huge indigenous knowledge base on which they rest. For eg., the farmers in the Zaheerabad region of the Deccan have a set of unique determinants for their biodiverse farming. They include *moisture requirement, pest proneness, labour intensity, weeding requirements, storability, food taste, soil types on which the crops are grown etc. They are also seeking from their farming not just food security but multiple securities such as fodder, cash, fuel, thatching/fencing material, rejuvenating soil fertility, ritual and cultural needs, medicinal use and an amazing array of things.* Any scientist would do well to learn from this worldview of sustainable farming. The farmers who gave information were not formally educated farmers. They were non literate dalit women in one of the "backward" regions of the country. This is also a lesson for those of us who have unflinching faith in the power of formal science and are ready to overlook people's science in favour of the former. .

The same kind of profound knowledge can be seen in the ways women from the farming communities approach seeds. They select seeds on five parameters: colour, odour, appearance, size, compactness of the panicle. They know exactly what material to use to store the seeds: reeds, grasses, soil, cowdung, wood ash, neem leaves, vitex negundo, addathoda vasica and such ecological methods. Sometimes, just the combination of seeds serve the storage purpose without the need to add any toxic material. For eg. mung bean is stored with foxtail millets and stays fresh and without any damage. And their stored seeds last the full season without any problem.

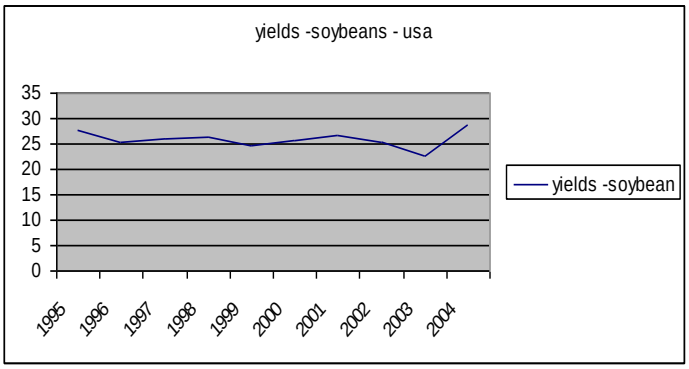
Therefore I would argue that the foundation of sustainable agriculture should be people's knowledge systems which are based on ecological understanding of their soils and environment.

Biotechnology in Agriculture

Biotechnology in agriculture runs completely against this grain of sustainable agriculture. It separates the domain of science from the domain of farming community. It externalizes everything that was internal to the communities and formed the basis of sustainability: seeds, manure, pest control and more than anything the community knowledge on agriculture. Biotechnology in agriculture today stands as the manifestation of corporate power that is shaping the food and farming policies in India. That is the reason why we must see biotechnology less as science and more as politics.

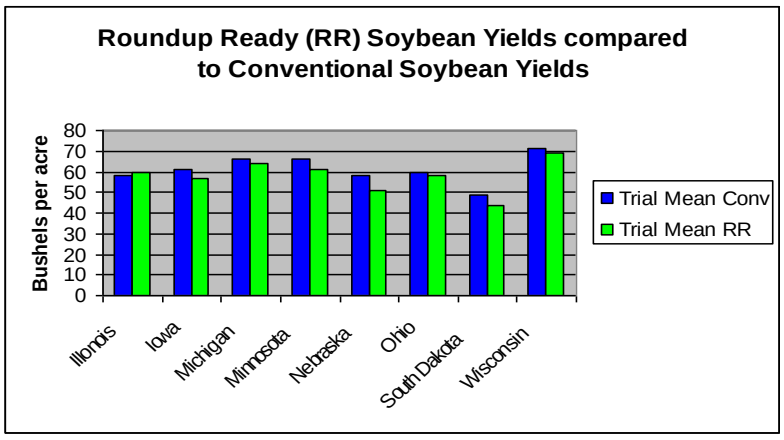
Biotechnology, strangely rides on the slogans of feeding the world and sustainability. It also claims that transgenics, a major product of biotechnology can increase yields and reduce pesticide use, two traits that have embraced more controversy than success. In order to examine the veracity of these two claims let us look at the home of transgenic crops, the USA which was the first country to grow GE crops and the largest planter of GM crops today. Nearly 55% of all genetically engineered crops in the world are cultivated in the USA today. More than 90% of all soy planted in USA and 85% of all corn planted in the USA are genetically engineered. In spite of this carpeting of the country by GE crops, has the yield dream been realized?

Look at the following graph for soy in the USA, released by the USDA, US Department of Agriculture:



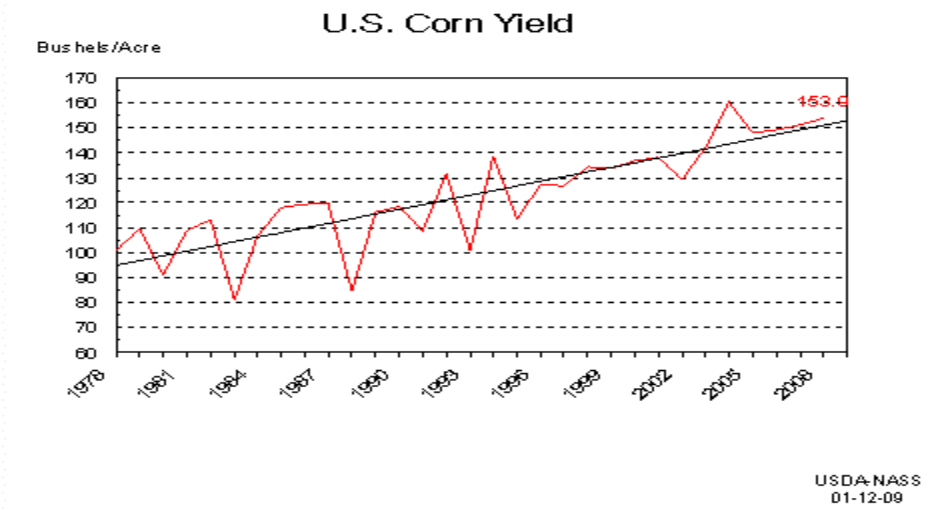
Between 1995 and 2005, the soy yield in the USA did not increase by even 1%. These years correspond to the prime GE period in US soy production. Instead of yield increase, soy yields fell from a peak of 42 bushels/acre in 1994 to 39.5 in 2009. In the interim years, it never touched the peak of 40 bushels/acre.

This fact is further amplified when we compare the yields of Round Up Ready Soy [a herbicide tolerant GE soy] with conventional soy yields.



In eight states where this yield comparison was studied, it was the conventional soy that out yielded the RR soy, as the graph exemplifies. Biotechnologists themselves describe this as Yield Drag**.**

Let us look at the corn production, another favoured GE crop. Corn production had in the USA touched 140 bushels/acre in 1995. In 2008 it was just about 150 bushels, a mere 7% increase in 13 years!



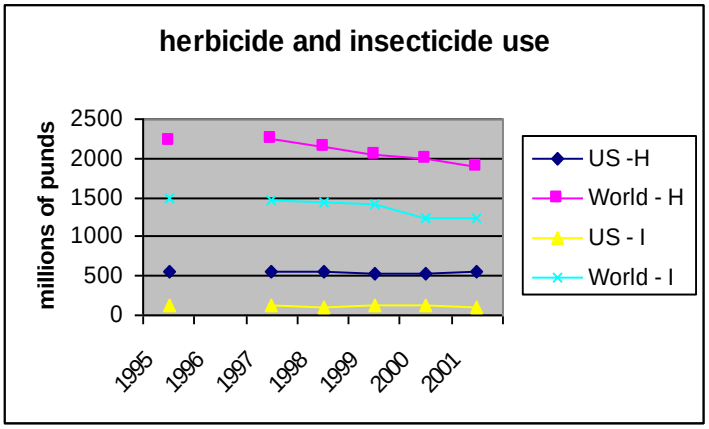
So where is the promised yield?

A Kansas University study in April 2008 provides us some answers.

> **The study showed that the productivity of GM crops (soya, maize, cotton and canola) was less than in the era prior to the introduction of GM seeds. Soya showed a drop in yield of up to 10%.**
>
> **In 2007, Nebraska University found that Monsanto's GM soya produced 6% less than the company's same variety in its non-GM version and up to 11% less than the best available variety of non-GM soya. Other studies including one of the US Department of Agriculture in April 2006 show similar results. Categorically, GM seeds are not the most high-yielding.**
>
> ***The main reason, the studies explain, is that genetic modification changes the metabolism of the plants which in some cases inhibits the absorption of nutrients and, in general, demands more energy to express characteristics that are not natural to the plant, denying it the ability to develop fully.***
>
> **When confronted with these facts, Monsanto's explanation was "genetically modified seeds are not designed to increase yields". (The Independent, April 4th 2008)**

While Monsanto has tried to explain itself out of this corner, its claim that its GE crops reduce pesticide use has not been muted. If at all, this is the resounding noise that the

company makes. Let us examine this claim from the US experience. The graph below issued by the US Environmental Protection Agency explains the total pesticide use in the USA vis a vis the world. Obviously with more than 55% of all GE crops being grown in that country, USA's pesticide use must be significantly less than the rest of the world. It is not so.



Between 1998 and 2002 world consumption of herbicides and insecticides indicate a clear down turn. But in the USA they are as flat as an airstrip. Another loud testimony to the fact that GE crops have not been able to make a difference to the use of pesticides.

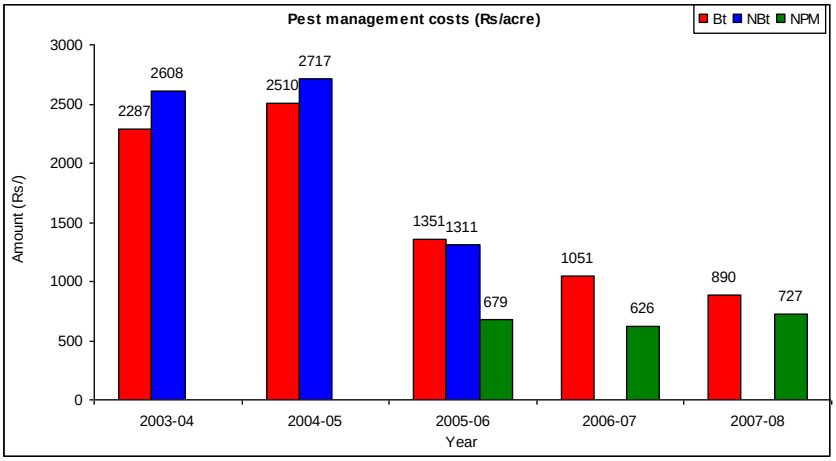
Closer home, in India it is the same story with the Bt cotton the first and the only GE crop grown in the country. The Deccan Development Society of which I am the Director and the AP Coalition in Defence of Diversity have been studying the impact of Bt cotton, particularly on the small and marginal farmers' fields in the South Indian state of Andhra Pradesh between 2002 [the year when the Bt cotton was introduced] and 2009. What are our findings till today?

The industry introduced Bt cotton with a bouquet of promises. They were:

- Bt cotton is a Cutting Edge Technology
- It is the answer to all cotton problems
- Use Bt cotton, it will lower the cultivation costs
- It will bring down the pesticide use significantly
- It will give farmers higher yields
- It will earn them higher profits

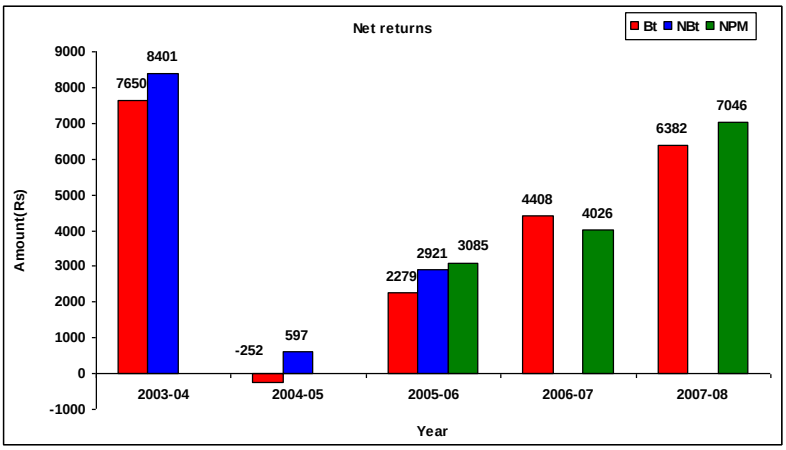
What was the outcome after five years, in 2007?

- Cultivation costs went up significantly
- Yields did not increase more than 5%
- Pesticide use has failed to come down
- Small farmer earnings are on the negative. They have lost more than what they have gained.



The above graph on pest management costs incurred by Bt and non Bt cotton farmers between 2002-3 and 2006-7 tells the complete story. While the first year of Bt cotton gave a marginal pest management edge to Bt growers, the very next year, Bt farmers spent almost the same amount of money as the non Bt farmers. Bt gave them no special advantage. Between 2005 and 2007 the study concentrated on the comparison between Bt growers and those farmers who had managed their pests under NPM methods. The NPM farmers scored a clear advantage. Their pest management costs, depending on rain and pest incidence regimes were far lower than the Bt farmers, sometimes just about 50% of the Bt farmers.

Over these five years, non Bt farmers invariably recorded higher net returns than the Bt farmers. In 2004, Bt farmers actually had a negative return while the non Bt farmers always had a positive return. Look at the graph below.



Another study by three researchers from the Hannover University of Germany done in the south Indian state of Karnataka on Bt cotton tells a similar story. Dr Hermann Waibel, Dr Ashok Malkarnekar and Dr Diemuth Pemsi of the Chair of Agricultural and Development Economics, School of Management and Economics, Hannover, Germany studied Bt cotton in two districts of Northern Karnataka. Their results for two seasons of 2002-2003 and 2003-2004 were as follows:

Bt-Cotton Production in Karnataka, India

2002/2003 season	non-Bt (n = 63)	Bt (n = 91)	[% diff.]
Yield [tonnes/ha]	1.39	0.97	-0.30 **
Price [US$/tonne]	401.48	393.47	-0.02 ns
Insecticide costs [US$/ha]	47.54	34.49	-0.27 ns
Seed costs [US$/ha]	16.94	85.41	4.04 ***
Total costs [US$/ha]	284.69	339.66	0.19 ns
Gross margin [US$/ha]	272.55	35.89	-0.87 **

2004/2005 season	non-Bt (n = 83)		Bt (n = 9)
Yield [tonnes/ha]	1.14	1.25	0.10 ns
Price [US$/tonne]	477.55	442.50	-0.07 ***
Insecticide costs [US$/ha]	35.12	21.95	-0.38 ***
Seed costs [US$/ha]	18.29	76.51	3.18 ***
Total costs [US$/ha]	183.68	231.92	0.26 ***
Gross margin [US$/ha]	338.85	289.23	-0.15 ns

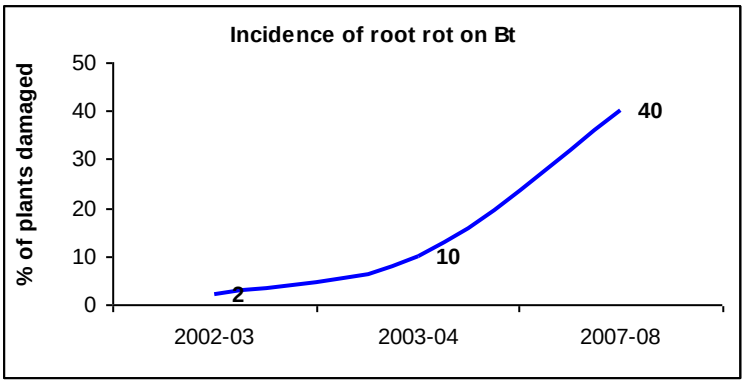
Ashok Malkarnekar, Diemuth Pemsl, Hermann Waibel:
Chair of Agricultural and Development Economics, School of Management and Economics, Hannover, Germany

Clearly Bt farmers suffered miserably in the first year and recovered marginally in the second. But even then they had lost nearly 20% more than the non Bt farmers.

Outside of these considerations of monetary gains and losses, if we start looking at the long term ecological devastations that Bt cotton has forced on the farmers in Andhra Pradesh, five major areas come to focus:

1 Serious damage to soil health
2 Return of the forgotten insects
3 Severe incidence of non target pests
4 Destruction of animal and human health
5 Death to humans and animals

Rhizectonia, the root rot disease which was rarely seen in the cotton belts of Andhra Pradesh increased from zero in 2002 to 40% of the soils growing Bt cotton in 2007. The consequent wilt disease spread like wild fire in many fields particularly of the small farmers. In despair farmers had to pull out the crops planted in their own hands and burn them. For an Indian farmer, this is akin to killing his own child. Nothing can make them feel more devastated.



One clue to this phenomenon was suggested by a study at the Indian Agricultural Research Institute (IARI), New Delhi which argued that transgenic Bt cotton may constrain the availability of nitrogen, but enhance phosphorus availability in some soil types in India. B.Sarkar and other researchers at the IARI determined that root biomass was not significantly different between the Bt and non-Bt cultivars during their growth. Root volume was also determined to be similar between cultivars at 60 days after sowing, but become significantly different after 60 and 90 days. The group hypothesize that the higher nutrient depletion is a consequence of an increased root volume of Bt-cotton which subsequently affected the chemical composition of root or microbial properties in the rhizosphere. http://dx.doi.org/10.111/j.1439-037X.2008.00312.x

Another IARI scientist Dr K R Kranthi of the Central Institute for Cotton Research, Nagpur said in one of his studies that Bt-cotton may affect soil microbes and nutrients available to the plants. “The Bt toxin has the potential to enter the soil through root secretion and from decaying roots where it comes in direct contact with soil microbes,” he said. The researchers compared the behaviour of microbes in soil under Bt cotton varieties and non Bt cotton varieties, both developed by Mahyco Research Centre. They found lower activity of certain soil enzymes (called dehydrogenase) in the soil growing Bt cotton compared to that with non-Bt cotton. Dehydrogenase enzymes indicate microbial population in soil; a drop in their activity means partially inhibited microbial activity, the study said. In terms of nutrient availability, the study found Bt cotton soil had lower mineral nitrogen than in non-Bt cotton soil. The researchers said Bt cotton has the tendency to take up more nitrogen compared to non-Bt cotton. Reduced microbial activity could have also affected nitrogen availability in soil as the microbes make nitrogen available to plants, the scientists said. Whatever the reason, the soils growing Bt cotton were turning toxic in various parts of India.

On the pest front, the sucking pests had a heyday occupying the space left by the helicoverpa while the long forgotten mealy bug a pest [forgotten from the ‘60s] came back menacingly to occupy the cotton crop in AP and Punjab. Punjab farmers paid a very heavy price for this pest in the 2007 season. The severity of the attack by sucking pests on Bt cotton fields were reported not only in the Indian Bt cotton fields but also in places such as Makathini in South Africa, Thailand where illegal Bt cotton cultivation was being encouraged by the officials of the agriculture department. This was a warning

in dealing with a pest complex in an unholistic fashion by targeting a single pest and not the causes of the pest attack.

As a report in the Business Standard explained :

` **A significant presence of these white-coated insects,[mealy bugs] viewed earlier as merely minor pests, was observed on the cotton crop in Gujarat in 2006 and, subsequently, in Punjab and the adjoining northern cotton-growing tracts in 2007. There have been reports of its growing populations from most other cotton-growing states as well. In 2005, the mealy bugs had destroyed almost the entire cotton crop in several parts of Pakistan, notably in Multan, Sanghar, Mirpurkhas and Tandu Allahyar areas.**

[From bollworms to mealy bugs,Surinder Sud (FARM VIEW) Business Standard, March 11 2008]

Human and animal diseases

In Andhra Pradesh, Bt cotton weeders and pickers suffered skin allergies that they had never experienced before. The same allergy afflicted animals like goat and sheep. In the year 2005, over 2500 sheep died grazing the left over Bt cotton stalks [traditionally cotton fields are opened for grazing after the harvest is over]. In the beginning the industry papered over this saying that they were after all small ruminants. But when buffaloes also started dying [we have counted nearly 12 of them], the answer by the industry was a deafening silence.

This prompted the researchers from DDS and Anthra, an organization devoted animal health to start an experiment of feeding the sheep under controlled conditions. Three groups of sheep were separated and each group was fed with stalks from Bollgard I, Bollgard II and Non Bt cotton. While two sheep fed with Bollgard I died within 3.5 weeks of the start of the experiment, one sheep fed on Bollgard II died with them. By the end of the fourth week, all the sheep fed with Bollgard had died while the sheep that did not feed on them stayed alive.

FED TO DEATH, SHEEP EAT BT COTTON AND DIE

- **Experiment started on 18th Feb 2008**
- **Three groups of sheep (each group consists of 3 sheep)**
- **Group 1- was fed on BG I**
- **Group 2 was fed on BG II**
- **Group 3- was fed on Non Bt**

AND THEY STARTED DYING

		BG I	BG II	Non Bt
First Death	March 13, 2008	1	-	Nil
Second Death	March 14, 2008	1	1	Nil
Third Death	March 18, 2008	1	2	Nil

While all these were happening around them and the farmers started losing their crops, money and hope a sense of despair enveloped them in the cotton belts of Andhra Pradesh. As a result several farmers committed suicide. Thus it was ironical that Bt cotton which was purveyed as a panacea against the farmer suicides, became its cause.

These tragic series of events led to huge protests by Bt cotton farmers. They blocked the main roads through sit-ins, attacked the seed depots, burnt hoardings of Bt seeds and expressed their anger in so many ways. It was quite a dramatic sight to see policemen guarding seed and fertilizer shops from farmers, the very people who had to sustain them.

The Government of Andhra Pradesh instituted its own enquiry into the failure of Bt cotton in 2005 and banned Monsanto seeds. It is another story that huge pressures from trade and industry as well as the US Government were brought to bear on the Government of AP which caved in under such pressures and revoked its ban order.

While all this was happening, the industry continued to paint a rosy picture of Bt Cotton. A number of industry-commissioned studies by commercial opinion pollsters claimed how Bt cotton had increased yields, reduced pesticide use, enhanced profits and changed the destiny of cotton farmers. And there were many scientists, prominent among them Dr Qaim [University of Bonn] who tried to explain away these problems as arising from "susceptible germplasm" The same set of arguments came from a stable of scientists who are committed advocates of biotechnology. All of them continued to claim that Bt cotton was succeeding in helping the poor. How does one explain this obvious contradiction between the ground reality and scholarly assertions?

Dominic Glover from the prestigious STEPS Centre of the Institute of Development Studies, University of Sussex, in his paper called ***Undying Promise: Agricultural Biotechnology's Pro-poor Narrative, Ten Years on*** offers some explanation for this contradiction:

> *This review of studies on the impacts of Bt cotton in China, India and South Africa shows that there is clear evidence of selectivity in the way that partial, ambiguous and equivocal data has been interpreted and represented. In all three cases, the story of success that has been highlighted on the surface has been shown to be, if not untrue, certainly only part of the story….. in a number of different, subtle but identifiable ways, encouraging results have been emphasised, while negative ones have been downplayed.*
> ***Undying Promise: Agricultural Biotechnology's Pro-poor Narrative, Ten Years on***
> **Dominic Glover, STEPS Centre, IDS, University of Sussex, Economic & Social Research Council**

So the controversy rages on. There is no concerted effort by the scientists outside of the corporate control and the government bodies to come together to make a dispassionate analysis of agrobiotechnology particularly transgenic crops especially when it is about to make incursions into our food crops. Starting with Bt eggplant, a host of food crops such as rice, mustard, soy etc are on the verge of getting approval by India's weak regulatory body for commercial cultivation. While on the threshold of this catastrophe, it will be worth our while to look at some of the warnings issued by Prof Jeffrey Smith, Institute for Responsible Science, USA.

> ***The prevailing worldview behind the development of GM foods was that genes were like Lego blocks, independent pieces that snap into place. This is false. The process of creating a GM crop can produce massive changes in the natural functioning of the plant's DNA. Native genes can be mutated deleted, permanently turned off or on, and hundreds many change their levels of expression. The inserted gene can become truncated, fragmented, mixed with other genes, inverted or multiplied, and the gM protein it produces may have unintended characteristics with harmful side effects.***
>
> ***GENETIC ROULETTE by Jeffrey Smith, published in India by SAGE, Deccan Development Society and Other India Press***

Thus the promise of biotechnology in agriculture sounds very hollow. As people who have worked at the grassroots with farmers who have planted Bt cotton and have suffered heavily as a consequence, we feel the thick blanket of half truths that wrap the dark secrets of the *success stories* of genetic engineering.

Therefore when the theme of this paper strings together Sustainable Agriculture, Biotechnology and Rural Development, we need, as I said right in the beginning a redefinition of all the terms.

Rural Development

How do we redefine the term development then? 35 years ago, the King of Bhutan made a visionary statement that for him the GDH [Gross Domestic Happiness] of his people was more important than the GDP of his country. While it was first received with a sense of bewilderment and a bit of amusement, slowly it has gained a lot of currency around the world.

While conventional development models stress economic growth as the ultimate objective, the concept of GDH claims to be based on the premise that true development of human society takes place when material and spiritual development occur side by side to complement and reinforce each other. The four pillars of GDH are the promotion of sustainable development, preservation and promotion of cultural values, conservation of the natural environment, and establishment of good governance.

While I leave the issue of spiritual development out of our debate, the combination of cultural values, natural environment and good governance can easily become the pillars of rural development when it is redefined to liberate it from a purely fiscal viewpoint.

At the centre of this development paradigm must be a sovereign community that has achieved complete control over its food systems. Such sovereignty, I argue, must govern food and seeds. While the food sovereignty must make it possible for each community to produce a diverse variety of ecosystem adapted foods that helps it to achieve complete food and nutritional security, the seed sovereignty must enable the community to establish complete control over its seed systems.

The reason I put a great emphasis on this is because I believe that food and seeds denote the emergency of an extraordinary governance system that is characterized by a high level of democracy, vibrancy and transparency.

The communities of dalit women that I work with in the Zaheerabad region of Medak District of Andhra Pradesh have made this ideal possible. Against all odds that include the multiple marginalisations inflicted on them by the mainstream society,

They have been able to do this by establishing a total control over their own seeds by each one of them becoming a household seed bank and by establishment of a network of community seed banks in their villages leading to community seed sovereignty. They have no need for outside seeds. Instead, they[dalits, women and very small farmers] are in a position to lend seeds to outsiders. This has also completely insulated them from the misery, despair and indignities suffered by the farmers dependent upon the state subsidized seeds.

Such an autonomy over their seeds has been intricately related to the ecological, biodiverse, women led farming that the communities in the Deccan have inherited from their ancestors. In their neighbouring districts, farmers who are dependent on hybrids and Bt seeds have seen their agriculture collapsing under the weight of external inputs [seeds, fertilizers, pesticides and knowledge]. But the autonomous agriculture of the DDS communities has never touched despair. In spite of droughts and other climatic catastrophes they remain spirited and triumphant.

The ultimate symbol of their autonomy is the Community Managed Alternative Public Distribution System that they have established in over 100 villages. Based on local production, local storage and local distribution, this system produces not just the food security but multiple securities such as health, nutrition, fodder, fibre, fuelwood, livelihood and more importantly ecological security. This firstever autonomous community PDS of theirs is the pinnacle of the other autonomies they have achieved.

These “other autonomies” include an autonomous healthcare system based on local heathcare traditions that use local plants and herbs, an autonomous market owned and managed by them, an autonomous community media trust that runs its own television and community radio.

This is the structure of rural development I always dream of. As I have repeated ad nauseum, this is based on people’s knowledge and retrieves for them not only their food and farming, but also their dignity and honour.

Therefore issues such as agrobiodiversity do not connote for them a sterile scientific event. Nor are they asking diabolical questions which some paid agents of the biotech industry who masquerade themselves as scientists ask: *Instead of getting romantic, sentimental, and politicize biodiversity, it is time to ask some dispassionate scientific questions in this contentious biotechnology and biodiversity debate:* ***How useful is this biodiversity?*** *….* ***Should all of it always be preserved in natural habitats or is it better***

preserved using modern biotechnology?[Dr Shantu Shantaram, BIOTECHNOLOGY IN DEFENSE OF BIODIVERSITY, FBAE blog]

It is against this extraordinary Orwellian society being created by the market agents and false scientists that we must defend our rural environs. It is only the community sovereignty that can bring this about. It is only then can we sustain not only our agriculture but also our societies.

> ***"What is needed is a new creation of the imagination that is of unprecedented importance..., a creation which would put at the centre of human life other meanings than the mere expansion of production and consumption, one which would offer goals in life that are recognized by other human beings as being worthwhile [....] This is the immense difficulty we are faced with. We should want a society in which economic values have ceased to be central (or the only ones), where the economy is put back in its place as a means for human life and not as its ultimate goal, and in which we therefore give up the mad race to consume more and more. This is not only necessary to avoid the final destruction of the planet's environment, but it is also and especially needed to rescue fellow human beings from psychological and moral misery".***[6]
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> **Cornelius Castoriadis** (1996)

These visionary words of the Greek philosopher Castoriadis sum up the way we should go forward in rural development. Towards a community sovereignty over its lands, natural environment and moral relationship with nature that manifests in a caring-nurturing attitude towards food and farming.

p v satheesh