Summary

Genetic Engineering (GE) has emerged as a significant tool, modifying living organisms across the natural barriers. It is a relatively new field of science in nascent stage of its development. Our current understanding of this technology is modest because of the vastness of gene pool and diverse unexplored genomes. However, this breakthrough science, based on recombinant DNA technology has been applied to various fields including pharmacy, medicine, forensics and agriculture. Its application in agriculture to modify major crop plants has been criticized on various grounds. Release of any genetically modified organism (GMO) in environment is fraught with lots of perils. Especially in case of Genetically Modified Crops (GMCs), their affect on ecology, environment, health, ethics, economy and society as whole has lead to perplexing debate.

Research and development of GMCs involves high precision science. It is an expensive technology involving lots of money. For such reasons, it is in hands of few powerful biotechnology MNCs of the world (Anderson, 2010). These Biotech MNCs see it as a good business opportunity. Therefore, they adopted and promoted this technology with an industrial approach rather than for benefit of mankind. This market driven approach of MNCs was criticized by various scientists and NGOs. Consequently these strong proponents and opponents of the technology soon brought it in controversy and directionless debate. These dubious contentions over the technology has deflected it form the path of progress.

GMCs are tagged with ecological problems like development of super-weeds, secondary pests, effect on non target pests and increased chemical usage (Benbrook, 2012). An important component of the research study was to assess the ecological implications of Bt cotton, only GMC approved for cultivation in the country. The ecological analysis involved conducting field surveys, conducting experimentation in three phases i.e. laboratory, glass dome and open field and Scanning Electron
Microscopy of cotton pollen and fibre. Comparisons between Bt cotton and conventional varieties were drawn at every level of ecological study.

Field surveys of Bt and non-Bt/conventional cotton fields of Punjab and Rajasthan, were compared for various characteristics. It included vegetation analysis, study of insect diversity, plant morphology and soil analysis. There was no significant difference noted in the vegetation growing in the vicinity of Bt and non-Bt cotton fields. But insect diversity of the Bt cotton fields was much lower than the non-Bt cotton fields. This was in direct contrast to claims of high specificity of the transgenic toxin of Bt cotton plants. Bt cotton plants depicted improved morphology over non-Bt cotton plants but it could not be ascertained if these improved morphological features were due to transgenic modification. Soil analysis of the Bt and non-Bt cotton fields showed no anomaly in macro and micro nutrient content, but higher values of EC suggested increased concentration of chemicals in ionic form in the Bt cotton field soil samples.

Experimentation over Bt and non-Bt cotton plants was done in three phases. First phase of laboratory experiments analysed the seed germination and seed vigour of Bt cotton, conventional and traditional cotton seeds. Bt cotton seed depicted increased seed vigour and seed germinability as compared to other two varieties. In the second phase, these three varieties were grown in two plots in Botanical garden of PU campus. Comparison of morphological features the three varieties highlighted the significantly better characteristics of Bt cotton plants than the other two varieties. Infestation studies were clearly depictive of the competitive advantage of the Bt cotton, transgenically modified to resist insect pest attack. Another experiment of forced infestation of Bt cotton plants with pink bollworms showed that it was not completely resistant to it and 40% survival rate of bollworm on Bt cotton plants was noted. The soil analysis of bulk and rhizosphere samples were repetitive of the results of the field survey with high EC and low OC values for Bt cotton samples.

Third phase of experimentation included open field trial on the field of 1 kanal grown with Bt and conventional cotton. The study depicted significantly better plant characteristics of Bt cotton but these do not correspond to an equal increase in the yield. Instead these improved morphological features inferred on ecological perspective show increased water stress. Soil analysis of rhizosphere and bulk samples of Bt and
conventional cotton fields suggested possible impact of Bt cotton on soil characteristics. The study necessitated need for further experimentation to achieve clarity in results.

Detailed surface topography of Bt and non Bt cotton pollens was studied applying scanning electron microscopy. The Bt cotton pollen appeared to be bigger and more in biomass than the conventional cotton pollen. But this was not found to be statistically significant. Similarly SEM analysis of fibre depicted that conventional cotton fibre was more coiled as well as more in thickness than the Bt cotton fibre. But statistically these differences were not found to be significant to draw a conclusive result.

Development and use of GMCs is not an isolated scientific technique. Right from research and development to its release in environment multitude of social, ethical and economic concerns comes into play. To analyse this societal perception over GMCs, sociological analysis was drawn using both qualitative and quantitative methods. First hand views of the people who influence GMC decision making was sought by the method of personal interviews. The exercise depicted highly biased and variegated approach of the individuals interviewed.

Broader perspective of public was sought by stakeholder surveys where opinion of the common man, retailers, farmers, MLAs and scientists was sought through set of separate questionnaires. Quantitative analysis of these questionnaires depicted low awareness levels in most of the cases except the scientists. Most of the stakeholders had a negative perception over GMCs. They lacked basic understanding of science behind these which further aggravated their dubious perception on the issue.

Urgent need is to have a stringent and science based policy over GMCs in place. The current Indian policy framework was reviewed for its efficacy. The analysis depicted many lacunae in the Indian regulation of GMCs. Multi-departmental control lacking any stringent biosafety and socio-economic evaluation was well evident. In the present form, there is no labeling, traceability and post cultivation monitoring regime. On global scale divergent and variegated approach on GMCs was visible. This divergent regulation dwelled more on the socio-economic and political status of the country and less on science and ecological principles. This global dis-harmony is aggravated in the absence of any stringent international legislation. Existing legislations are not ratified by all the countries like Cartagena Protocol on Biosafety. Thus, it makes the trade and commerce of GMCs across the countries difficult.
The research study aimed at gauging the sustainability of GMCs in tune with natural principle and analyzing the ecological basis under existing legal/policy framework. These may appear sustainable incase of a specific crop or specific trait or specific area. But on long term basis, under current scenario of lack of scientific expertise, efficacy of Bt crops, societal perception and weak regulatory framework, GMCs prove to be an unsustainable option. Need is to evaluate these crops on long term ecological and biosafety aspects and then develop an effective regulatory framework. As in the words of Albert Einstein (1956)

“Science can only ascertain what is, but not what should be, and outside its domain value judgments of all kinds remain necessary”.

So is the case with GMCs. We need to assess and find out their real value for mankind. We need to ascertain their real purpose, impacts, efficacy, and benefits extending to all segments of society, before adopting them.