ABSTRACTS

CROP BIOTECHNOLOGY IN THE UNITED STATES – A CASE TO UNDERSTAND WHY INDIA CANNOT MISS THE BIOTECHNOLOGY TRAIN

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The Green Revolution in the 60's enabled Indian growers to harness the productivity potential of such crops as rice and wheat and increase the nation's food security. For the first time in years, India is once again facing food shortages. Sustainable and proven technologies such as agricultural biotechnology are needed to usher in a second green revolution to address and meet India's growing population and food shortage needs.

This paper discusses the biotechnological advances in American agriculture and why American growers are planting crops derived from this technology at a rapid pace and with an overwhelming enthusiasm since 1996. The paper, furthermore, sets the stage to understand the need for and potential of this technology in India.

American growers continue to lead the farmers worldwide in the adoption of biotechnology-derived crops by planting 122 million acres in 2005, the tenth year of their commercial planting. Benefits reaped from the technology have been the driving force in the expansion of the planted acreage from 5 million acres in 1996 to 122 million acres in 2005.

American experience from a decade-long planting of biotechnology-derived crops indicate that these crops have provided simple, reliable, and flexible alternatives to traditional pest management choices, reduced the total amount of input costs in farming, and improved crop yields, all of which have translated to direct economic benefits to farmers. Biotechnology-derived crops planted on 118 million acres in 2004 increased crop productivity by 2.4 billion kilograms, lowered crop production costs by $1.7 billion, and reduced the overall pesticide use in production agriculture by 28 million kilograms. The numeric value of the benefits reaped from biotechnology-derived crops in 2004 was improved grower net returns of $2.3 billion.

Biotechnology has delivered benefits to small and big farmers alike in the United States. The scale-neutrality of biotechnology is evident from plantings of minor crops such as papaya and canola, the adoption rates and benefits of which were similar to large acreage crops such as corn and soybean.

Similar to that noted in the United States, crop biotechnology can facilitate improvements in crop productivity, nutritional quality, food security, and sustainable agriculture in India also. This, however, can be achieved only through coordinated efforts to dispel the myths and enhance the awareness of the positive impacts that could result from the technology and open discourse between various stakeholders.

India's technological prowess has made it a leading global player in information technology. Strategic investments in crop biotechnology will enable India to play the same role in agriculture arena also and to address issues related to its burgeoning population, shrinking farmland, and food shortages before they become acute.

FEEDING PEOPLE, GENERATING INCOME, AND PROTECTING THE ENVIRONMENT IN RURAL INDIA : ROLE OF AGRICULTURAL BIOTECHNOLOGIES

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Investment in agricultural research and development in the past few decades has helped to improve the lives of most Indians through enhanced and affordable food supply, boosted incomes for millions of our farmers, and reduced the incidence of famine and starvation despite massive population increases in the past few decades. Nevertheless, food insecurity and malnutrition still persists in India. The causes for poverty and hunger are varied and complex, but experts concur that sustainable agricultural development will be critical in meeting future food needs, reducing poverty and protecting the environment.

To further increase agricultural productivity equitably-in an environmentally sustainable manner in the face of diminishing land and water resources-is a highly challenging task ahead. Knowledge-based approaches including genetically modified crops and genomics can provide powerful solutions enhance food security: by improving local agricultural productivity, minimizing the use of chemical inputs such as pesticides and fertilizers, insulatsing crops against losses from diseases and pests, curtailing post-harvest losses including food spoilage, improving food quality and nutrition, increasing crop tolerance to stress factors such as drought and problem soils, and through the production of 'value-added' products. Biotechnology can expedite the development of new varieties and also enhance marginal crops like millets, pulses, oilseeds and other important staples in India.

Unlike the green revolution, which entailed the use of high capital inputs, biotechnology delivers the added value primarily through the seed. Thus, it is conceptually a 'scale neutral' technology: small farmers can benefit from it as much as rich farmers, if the improved plant material is accessible and affordable. Judicious application of biotechnology can boost rural incomes and thus improve the purchasing power of a marginalized section of the developing societies.

The integration of biotechnology into agricultural research in India is fraught with many hurdles that must be addressed including financial, technical, political, environmental-activist, intellectual-property, biosafety and trade-related issues. Considering the constraints, it is important to focus the application of biotechnology to a few strategically chosen high-priority areas where the technology provides the most gains.

Public sector institutions such as ICAR and agricultural universities Have major responsibilities in facilitating the integration of biotechnology into agricultural research on staple crops while the private sector would cater to the needs of highly commercialized seed sector.

To ensure that India can harness the benefit of emerging agricultural technologies with minimal problems, concerted efforts must be pursued to create an awareness of its potential benefits and to address the concerns related to its use through dialog among the various stakeholders : policy makers, scientists, trade groups, food industry, consumer organizations, farmers groups, media and NGOs.

BIOTECHNOLOGY IN AGRICULTURE IN THE CONTEXT OF COUNTRY'S FOOD SECURITY

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National Agriculture Policy (NAP) of India recognised the importance of food and nutritional security. The policy highlights the special efforts to be made to raise the productivity and production of crops to meet the increasing demand for food generated by unabated demographic pressures and raw materials for expanding agro based industries. A regionally differentiated strategy has to be pursued, taking into the agronomic, climatic and environmental conditions to realise the full growth potential of every region. Special attention has to be given for the development of new crop varieties, particularly of food crops, with higher nutritional value through adoption of bio-technology through genetic modification, while addressing biosafety concerns.

A major thrust is to be given for the development of rainfed and irrigated horticulture, floriculture, roots and tubers, plantation crops, aromatic and medicinal plants, bee keeping and sericulture, for augmenting food supply, exports and generating employment in the rural areas. Availability of hybrid seeds and disease-free planting materials of improved varieties, supported by network of regional nurseries, tissue culture laboratories, seed farms has to be promoted to support systematic development of horticulture having emphasis on increased production, post harvest management, precision farming, bio-control of pests and quality regulation mechanism and exports. Fruits and vegetables are the key growth area for enhancing nutrition to the poor people through increased availability at cheaper prices.

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In a quest for increased food production for ever increasing human population and to maintain the food security, the potential benefit of Green Revolution in agriculture has already been harnessed by the nation. Slowing down of the foodgrain production to 1.50 per cent against population growth of 1.80 per cent is a matter of concern. Often it is told that the second Green Revolution is to come from "Gene Revolution". Genetic Modifications is thus an important tool to pursue the goal of sustainable, diversified and increased food production through higher productivity, safety and more efficient and environment-friendly pest control. This goal is one of the key objectives of the World Food Summit held in Rome in November 1996.

Bio-technology is bringing revolutionary changes in crop production and management techniques. It is being considered as an important scientific tool to increase agricultural productivity, reduce the dependency on conventional insecticides and herbicides reducing thereby the risk of environment pollution, improve the quality of nutritional contents and of food products and bring higher net economic returns to the farmers. A number of developed and developing countries including USA, Argentina, Canada, Australia, Mexico, Spain, France, South Africa and China are growing genetically modified plants. From an estimated three billion $ of produce in 2000 A.D. , the global market for transgenic crops will go to the extent to twenty five billion $ by 2010. The crop area under transgenic crops has substantially improved from 1.7 million hectare (m ha) in the year 1996 to 81 m ha in 2004. About 47.6 m ha area that is 59% of total transgenic crop is in USA alone.

However, the world-wide adoption and marketing of these technologies on the products derived from them is being increasingly put in doubt by two main factors namely lack of harmonies of regulatory systems and lack of public acceptance for these products. World-wide commercialization of biotechnology has occurred at a faster rate than the development of regulatory frameworks and trade rules or than the rise of consumer awareness about the values of biotechnology and the safety of Genetically Modified Organisms for human, plant and animal health and the environment. These factors have resulted in the creation of trade barriers for Genetically Modified Organisms in many countries and regions, particularly in the European Union (EU) where non science based concerns have politicized their approval process, grinding it to a virtual halt and creating serious trade problems.

The role that each trade agreement plays in addressing barriers to biotechnology depends on whether the barrier is about :

- Market access for biotech products entering international trade ;
- Intellectual property protection for biotech inventions ;
- Protection standards for the health and safety of humans, animals and plants ;
- Consumer labelling standards, or ;
- Protection of bio-diversity and genetic resources.

These techniques are going to be a powerful new tool to supplement pathology, agronomy, plant breeding, plant physiology and other approaches that serve us now. If agri biotechnology techniques are developed and applied in a manner consistent with ecologically sound agricultural practices, they could decrease reliance on broad spectrum insecticides which cause serious health and environmental problems. Agri-biotech techniques are highly compatible with the goal of sustainable agriculture because they offer surgical precision for combating specific problems without disrupting other functional components of the agriculture system. Agricultural biotechnology may be the last Brainstorm for the agriculturist to save the plant from the polluted environment and to maintain the improvement in productivity for the ever increasing population of the globe. The risk and benefit are the two facets of the same coin and all human activity carries this along. The agricultural scientists have the responsibility and accountability to work for the improvement of crops and are vigilant about all possible risks, which are associated with their scientific endeavor to improve the food security. India needs these technologies the most. If we compare our yields in comparison to the worlds yield, we are still lagging behind, almost half in many crops. This gap we have to fill by using innovate technologies.

The new technology has many issues tagged to it and acceptable solutions have to be found so that this technology can progress without hurdles in a definite span of time. The most important issue is intellectual property rights which is itself very complex. Most of the technologies which are being used alongwith gene transfer are patented and to get access to these technologies, workable arrangement has to be made so that the freedom to use these technologies can be ensured.

The other issues regarding biosafety, environmental safety and risk to the biodiversity are being handled with the generation of lot of data thereby showing the safety of this technology. But the perception of this technology in the mind of the public is still very vague. Creation of people's awareness for the social and economic benefits from this technology is thus considered to be one of the most important activities for the acceptance of the technology in the country.

The scientific community has to demonstrate the fact that this technology is a part of the big agenda for crop improvement. India needs this technology the most. We have to demonstrate scientifically the positive features of this technology. India has to clearly define the regulatory policies but has to avoid over regulation of this technology because, over regulation will lead to discouragement and delay in agriculture growth. The fears in the mind of public are many but these fears are of unknown nature and sufficient scientific data is being generated to clear the cloud of these fears. We have to weigh the risk-benefit ratio of this technology so that a logical decision can be made in favour of these technologies and in releasing the product.

GENETIC TRANSFORMATION OF S.BICOLOR (L.) MOENCH BY P5CS GENE CONSTRUCT FOR SALT AND DROUGHT STRESS TOLERANCE

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Salt and water stresses are the major scourges for crop productivity. Nearly 45% of the total land is arid and semi arid besides 20000 miles of typical desert sea coasts. There are 400 million hectares of land through out the world affected by saline conditions. About 20% of the world's cultivated land 50% of all irrigated lands are affected by soil salinity. One way to achieve the food target and to feed the ever increasing world population is to bring under cultivation the lands that are drought and salt affected. This can be achieved only by developing stress tolerant crop plants. New genes can be introduced into crops that confer valuable traits such as drought and salt stress tolerance by *Agrobacterium* and Particle bombardment methods. Callus cultures were derived from different explants and varieties of sorghum and protocols for somatic embryogenesis and organogenesis were standardized. A gene construct containing the *vigna p5cs* was made with PCAMBIA vector and transferred into *Agrobacterim*. Shoot apics from seedlings of drought susceptible sorghum varieties were transformed with the above gene construct using *Agrobacterium* and also by particle gun were characterized by Southern analysis and by quantifying proline levels. Also, amplification of the *hpt II* was observed only in transgenics but not in the DNA isolated from seed raised plants. The T_0 transgenic plants were transferred to the soil and were grown to maturity. The plants were selfed and the seeds were collected by plant wise. Progeny analysis of the transgenics revealed a typical Mendelian inheritance (3:1) pattern of the transgene. T_1 seedlings were exposed to 150mM NaCl and also to drought stress imposed by PEG, which performed better in the pot conditions when compared to their corresponding controls.

GM RICE IN RETROSPECT AND PROSPECT

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Genetic modification (GM) of plants has been the basis for betterment of crops in modern agriculture. Farmer's practice of seed selection and conscious hybridization has lead to the evolution of wide range of crop varieties. The power of these practices was greatly accelerated with the application of science of genetics leading to modern hybrid varieties in food crops like maize, sorghum, pearl millet and high yielding semi dwarf inbred varieties in self pollinated crops like rice and wheat that were considered as flagship of green revolution. The green revolution offered farmers modern varieties that improved farm yields under intensive input management. Increased use of fertilizers and pesticides threatened long term sustainability of green revolution technologies. Amidst challenges of population escalation, depletion of natural resources-land and water and destabilizing factors–biotic and abiotic stresses, the way forward to step up production is to develop and deploy innovative technologies that enhance output per unit of input without deterrent to environment and production.Recent advances in new biology collectively known by the term Biotechnology promise to not only advance productivity further but also to address some of the intractable problems and constraints both in high production environment and also in gray and fragile areas. Biotechnology is largely associated with genetic manipulation at DNA level and most important application has been the development of genetically modified crops. Genetic engineering conferred the capability to mobilize useful genes across reproductive and phylogenetic barriers extending the horizon to access genetic diversity from biological gene pool. Though no commercial transgenic rice line is released yet, transgenics of rice either under farm scale evaluation or in development can be grouped under four categories i, herbicide tolerance ii, biotic stress resistance iii, abiotic stress resistance and iv, nutritional traits. The gains from GM technology already introduced in developing countries like India (eg. Bt cotton) is predominantly economic benefits for farmers; its real potential for rice is in addressing chronic nutritional problems.

Genetic installation of pathway for synthesis of ß-carotene (pro-vitamin A), a precursor of vitamin A in the rice grain, considered as *tour de force* in genetic engineering has resulted in the development of a prototype of "Golden rice". As some of the gene constructs, promoters and selectable markers used initially, were found unsuitable for commercialization and deregulation, step-wise efforts by public and private sector, over the last six years could yield transgenic rice lines rich in pro-vitamin A near sufficient to meet the recommended daily allowance. Golden rice though, not a proverbial silver bullet, holds potential to provide improved nutrition for the poorest of the poor. Aside golden rice, next in importance is the development of Bt rice for resistance against stem borer. Bt rice offers resistance against lepidopteron insect damage reducing the yield losses and a safer and economic option for pest control. Most significant work was carried out to develop and field evaluate Bt rice in China and at IRRI. Transgenic Bt rice hybrids have also been undergone field trials in China and are close to commercialization.

The adoption of GM crops in agriculture in general is, however, controversial and concerned about possible health and environmental effects. The development and adoption of GM rice depends on prospects of delivery of high yielding, pest resistant and nutritionally rich rice. And availability of such GM rice will largely rests on the extent of efforts of public sector research. A superior genetically engineered trait is an incentive for private sector to conjunctively use GM technology in rice hybrids. Rice being the major food crop, the drive for GM rice may well result in faster acceptance of the GM crops in general.

TRANSGENICS IN OILSEED CROPS

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Among oilseed crops, biotechnological applications have already fructified in rapeseed, soybean and sunflower in the form of useful genetically modified crops. Herbicide tolerant (HT) soybean and canola are commercially released and HT soybean occupies 63% of global transgenic area. Oil quality improvement through genetic engineering has become a success story in crops like soybean and *Brassica*, with several transgenics having been produced and commercialized to meet the specific demands of human consumption and industries. The concept of designer oilseed crops where the same crop could be modified to produce oils with different fatty acid profiles to meet varied demands of human requirements has become a reality with the production of different transgenics in *B. napus* as well as soybean. There is a need to extend this technology of modifying fatty acid profile to other oilseed crops to exploit the full potential offered by it. Transgenic technology should also be adopted to circumvent the susceptibility of oilseed crops to several biotic stresses like pests and diseases that beset cultivation of these crops. Since most of the oilseeds are grown on marginal lands and under rainfed conditions, engineering of traits that confer resistance to environmental stresses, such as drought, frost, water logging or salinity could contribute to increased or sustained productivity. As transgenics offer an environmentally safe proposition to mitigate the stresses (both biotic and abiotic), it helps in sustainable agriculture. This review presents the current status of advancements in transgenic technology in annual oilseed crops and provides an overview of the areas of research that need to be developed in annual oilseed crops.

ROLE OF BIOTECH CROP FOR FOOD SECURITY

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ENHANCING PUBLIC UNDERSTANDING OF AG-BIOTECHNOLOGY IN INDIA

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Potential of agriculture biotechnology for a developing country like India is well realized. Biotechnology can be viewed as one of the very important tools for fostering agriculture growth especially in view of the decreasing natural resources like land and water and increased need for food production.

The agriculture biotech sector in India is making rapid strides, especially since the release of first transgenic crop, the BT cotton, which has been grown on more than 1.3 million, hectaers of Indian land by about one million farmers. The rapid adaptation growth of Bt cotton paves the way to many other transgenic crops and traits for India. Rapid incorporation of new technologies, increasing demand for better quantity and quality of ago-produce brings in new challenges to Indian agriculture and one of the most prominent challenges is to prepare the system for understanding and accordingly benefiting for the various agri-biotechnologies.

Farmers are one of the most important stakeholders of ag-biotechnology playing an important role as 'end-users' of the various ag-biotechniques. There is a limited understanding among the Indian farmers regarding biotechnology and this becomes a major reason for various communication problems associated with the acceptance of biotechnology in a sustainable manner.

At this stage it is imperative to strengthen our investments in building effective communication link between the science of ag-biotechnology and its end users, the farmers and the public in general.

While reviewing the various stages of communication between lab to land, my presentation shall especially focus upon the initiatives taken by the South Asia Biosafety Program (SABP). SABP is an international developmental program supported by the USAID and being implemented in India and Bangladesh by the Agriculture and Biotechnology Strategies (AGBIOS) and International Food Policy Research Institute (IFPRI).

As a part of the communication initiatives of SABP we have undertaken several programs in India that focus upon strengthening public understanding of ag-biotechnology. I shall discuss our initiatives and experiences from the state level programs designed especially for grass roots level workers and extension personnels in India.

SAFETY OF BIOTECH FOODS

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As a result of development in gene technology, it is possible to confer new traits to plant, animal or microbial species by introducing genes into genomes of target tissue. Several commercially important transgenic crops such as maize, soyabean tomato, cotton, potato, mustard and rice have been genetically modified for following traits like herbicide tolerance, insect resistance, disease resistance, and quality improvement.

The biosafety or potential risk from use of genetically modified organisms (GMOs) and their products can be broadly categorized as risk to human health, environmental, ecological changes, social and ethical issues.

Another guideline followed by all the regulatory authorities including the WHO is the concept of substantial equivalence. This involves comprehensive biochemical/ molecular comparison of a genetically modified (GM) food and its conventional equivalent and a detailed analysis of any differences. Mostly GM foods are generally acepted as safe (GRAS). The difficulties of applying traditional toxicological testing and risk assessment procedures to whole foods, or otherwise, make it pretty well impossible to establish absolute safety. The aim of the substantial equivalence approach is to consider whether genetically modified food is as safe as its traditional counterpart.

Process begins with comparison between GM plant/food with its closest traditional counterpart in order to identify unintended/ intended differences. These differences then become the focus of safety assessment and if necessary, further investigation. Factors taken into account in the safety assessment include :

- Identify and source of novel genes
- Composition of plant/food derived from it compared with its traditional counterpart
- Effects of processing/cooking
- Methods used to make GM plant
- Stability and potential for transfer of novel gene/genes
- Potential changes in function of novel genes and proteins
- Potential toxicity of novel proteins
- Potential allergenicity of novel proteins
- Possible secondary effects resulting from expression of novel gene or genes for example by disruption of a gene in the host plant, knock on effects on metabolic pathways and changes in production of nutrients, antinutrients, toxins, allergens and physiologically active substances
- Potential intake and dietary impact of the introduction of the genetically modified food

BIOTECHNOLOGY FOR SUSTAINABLE AGRICULTURE IN THE SEMI-ARID TROPICS

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Poverty continues to limit access to food, leaving hundreds of millions of people hungry and undernourished in the developing countries. Although conventional crop improvement approaches have achieved commendable results, due to increased food demands of the burgeoning population and urbanization, and new biotic and abiotic stress challenges to crop productivity, yields of several crops have already reached a plateau. Most of the productivity gains in the future will have to be achieved through better management of natural resources and crop improvement. Since the limited variability in the available germplasm for several constraints is a major bottleneck to crop improvement, future breakthroughs will depend on the creation of additional variability and inflow of desirable traits from related or unrelated species. New technologies, such as biotechnology offer the potential to enhance agricultural crop productivity and move agriculture from resource-based to a science-based industry. The applications of biotechnology range from the simple techniques such as tissue culture and micropropagation to the more sophisticated ones based on molecular markers and genetic engineering. Through genetic engineering, transfer of genes from heterologous species provides the means of selectively introducing new traits into crop plants and expanding the gene pool beyond what has been available to traditional breeding systems. In general, the aim is to improve the efficiency, effectiveness, speed and precision of plant breeding for various constraints like abiotic stress tolerance, pest and disease resistance, better agronomic traits, and improved food, feed and fodder quality. Biotechnological approaches and their current status at ICRISAT to achieve sustainable crop productivity, food security and poverty alleviation in resource-poor developing countries of the semi-arid tropics will be discussed.

RADIATION TECHNOLOGY FOR THE DEVELOPMENT OF GENETICALLY IMPROVED CROPS AND POST HARVEST PROCESSING OF AGRICULTURAL COMMODITIES

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Availability of wide range of genetic variability is the main stay of plant improvement. Improvement of economically important plants can be achieved by cross breeding, somaclonal variation, recombinant DNA technology or mutation breeding. Mutation breeding is one of the important tools for creating the genetic variability in a very short period of time. The novel genes identified in induced mutations can play an important role for preserving and upgrading biodiversity. Mutations may alter one or more of the yield contributing factors leading to higher yields and / or impart resistance to biotic and abiotic stresses. Mutations may also alter flowering time and response to day length. Radiation induced mutations for modification of plant architecture, root characteristics and quality and nutritional parameters such as oil and protein quality and quantity, low antinutritional factors, seed size, colour etc are known.

At BARC, radiation induced mutation techniques were successfully used for creating genetic variability in important crops. This induced variability was directly used or utilized in breeding programme to develop improved plant types. Using radiation induced mutation and cross-breeding, B.A.R.C. developed 26 improved varieties have been released and notified for commercial cultivation by the Ministry of Agriculture, Government of India. These include : 13 in oil seeds (10 groundnuts, 1 soybean and 2 mustard); 11 in pulses (4 blackgram, 5 greengram, 2 pigeonpea) and 1 each in rice and jute. Some of these have made good economic impact. Another major activity, has been the development of DNA molecular markers for identification of crop varieties, marker assisted selection and tagging and cloning of desirable genes.

Over 25% of the agriculture produce is lost due to spoilage because of variety of reasons. Thus conservation and preservation of food is prerequisite for food security and sustainable agriculture. Providing safe food which is pathogen free is also equally important. Radiation processing is one of the upcoming method to achieve this . Food preservation using radiation involves controlled application of energy of radiations such as gamma rays, X-rays, and accelerated electrons to food and agricultural commodities. The technology can complement and sustain agricultural productivity. It provides an effective alternative to fumigants, which are being banned and phased out due to their deleterious effects on human health and environment. Radiation can be a very good tool for value addition to raw agricultural commodities. This is because irradiation is a cold process. It does not increase the temperature of the commodities, and therefore, it does not affect the freshness or natural form of the agricultural commodity. Due to highly penetrating nature of the ionizing radiation, the processing can be done in pre-packed commodity. This avoids the risk of post-processing contamination.

Radiation processing technology has been developed for: a) Sprout inhibition of potato, onion, garlic and ginger for improving marketability during storage. b) Insect disinfestation of agricultural commodities for preventing losses due to stored product insects, and overcoming quarantine barriers in international trade. c) Hygienization of spices. d) Extension of shelf-life of fish and meat and reducing risk of food borne-diseases. Radiation processing can also be used for non-food products like cut flowers, health foods, herbal and ayurvedic preparations, cattle feed, dog/pet foods and packaging materials.

Use of radiation for ensuring bio-security will become increasingly important in future for international trade in agricultural commodities. In our efforts to deploy radiation processing technology on a wider commercial scale about a dozen MOUs have been signed between DAE and entrepreneurs in private and cooperative sectors. Few commercial irradiators have become operational and others are in different stages of construction.

INTRODUCTION OF BACTERIAL LEAF RESISTANCE INTO SAMBA MAHSURI

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Samba Mahsuri (BPT5204) is a leading rice variety of Andhra Pradesh that was developed almost two decades ago by scientists at the Acharya NG Ranga Agricultural University. This variety is favored by farmers and consumers because of it's high yield and exceptional cooking quality. Because of these characteristics, cultivation of Samba Mahsuri is spreading to many parts of India. However, Samba Mahsuri is susceptible to many pests and diseases, including bacterial leaf blight (BLB).

In collaboration with scientists at the Directorate of Rice Research, we have introgressed three different rice genes for bacterial leaf blight resistance into samba Mahsuri using molecular market assisted selection. The developed lines exhibit very good resistance against BLB and appear to retain the yield and quality characteristics of the original Samba Mahsuri parent. These genes are undergoing national multi-location field trials under the All India Coordinated Rice Improvement Project (AICRIP) of ICAR. They will be released for commercial cultivation if they are found to be suitable during these trials.

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INTERNET RESOURCES IN AGRICULTURAL BIOTECHNOLOGY

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Internet, of late, has become an integral part of our lives. It helps us in all walks of life; be it information, communication or entertainment. It has shown tremendous growth in past few years and is expected to grow further. India is not an exception to this; with more than 50,600,000 users at present. This enormous growth is rapidly changing the way in which the information is acquired, stored and distributed. A wide array of internet resources are available in the agriculture sector which range from enhanced information dissemination pertaining to research and development, extension and marketing, to farmer-specific resources for timely dissemination of information pertaining to modern/alternative farm practices, disease information, market information, weather forecasting, agricultural statistics, agricultural policy and programs, etc. However the internet has a darker side too. The information inflow is so fast & vast, that it is very difficult to keep track of all the happenings in this field. Millions of pages are available on the net and thousands are added everyday; the paradox of 'information overflow' has begun to take over. As a consequence, data mining has emerged as one of the biggest challenges of the present times. In this context, an attempt has been made here to cluster and present some of the most valuable internet resources pertaining to agriculture sector in general and agricultural biotechnology sector in particular. Special emphasis has been given to compile 'India specific' resources which can be of great help to Indian farming and research communities.

Keywords : Internet, resources, agriculture, biotechnology, India.

ROLE OF PLANT GROWTH PROMOTING RHIZOBACTERIA IN ENHANCEMENT OF PLANT GROWTH

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Abstract :

Numerous species of soil bacteria which flourish in the rhizosphere of plants, but which may grow in, on, or around plant tissues, stimulate plant growth by a plethora of mechanisms. These bacteria are collectively known as PGPR (plant growth promoting rhizobacteria). The search for PGPR and investigation of their modes of action are increasing at a rapid pace as efforts are made to exploit them commercially as biofertilizers. After an initial clarification of the term biofertilizers and the nature of associations between PGPR and plants (i.e., endophytic versus rhizospheric), this review focuses on the known, the putative, and the speculative modes-of-action of PGPR. These modes of action include fixing N2, increasing the availability of nutrients in the rhizosphere, positively influencing root growth and morphology, and promoting other beneficial plant–microbe symbioses. The combination of these modes of actions in PGPR is also addressed, as well as the challenges facing the more widespread utilization of PGPR as biofertilizers. Free-living plant growth-promoting rhizobacteria (PGPR) can be used in a variety of ways when plant growth enhancements are required. The most intensively researched use of PGPR has been in agriculture and horticulture. Several PGPR formulations are currently available as commercial products for agricultural production. Recently developing areas of PGPR usage include forest regeneration and phytoremediation of contaminated soils. As the mechanisms of plant growth promotion by these bacteria are unravelled, the possibility of more efficient plant-bacteria pairings for novel and practical uses will follow. The progress to date in using PGPR in a variety of applications with different plants is summarized and discussed here.

ARTICLES

BIOTECHNOLOGY IS NOT THE ENEMY

The incessant cacophony raised by several Anti-GM NGOs is reaching an all-time high with their declaration of April 8th as Anti-GMO Day. Their holier-than-thou attitude is raising the issue of GM crops to uncalled-for genocidal/ gargantuan proportions. Play a simple game of word association and their arguments ricochet as "baseless", "one- tracked" and " vested".

If so concerned about the alleged ill-effects of biotech crops, why not enter into a fruitful discussion with all stakeholders? We have offered Vandana Shiva 10 acres farm land freely for conducting trials on Bt and Non-Bt cotton. It is yet to be answered.

This offer still stands to any one of the NGOs willing to take up. The activists must learn that one can not form public opinion without scientific and market analysis on their side. They must present views based on rock-solid facts, and not intuitions. The NGO's however seem to rely on the wide-spread panic they try to instill in the masses to get public backing. The fact seems to be that most of these anti-GMO NGOs are urban based, non-farming communities whose carrier is anti-farmer activism as a profitable occupation. Of course, they seem to be prospering well in this profession.

Fortunately, informed people know that India has a lot to gain from plant biotechnology – agronomic and social growth, higher per capita income, self-sufficiency in crops such as cotton.

The Indian farmer has even more to gain from GM crops – higher yields, lesser insect damage, lower input costs, and better returns. Ironically, the biotech crops also benefit the anti-GM activists – reduced emissions of greenhouse gases and decreased usage of pesticides. Isn't a record 14 per cent reduction because of the use of GM crops in the environmental footprint associated with pesticide in everyone's interest?

The 2005 IMRB survey showed that in Andhra Pradesh, the net profit increase for Bollgard Bt Cotton farmers was highest at 551 per cent, with pesticide use against bollworms being reduced by about 5 sprays. The total additional benefit accruing to the Bollgard farmer was Rs 5887 per acre. Moreover, the yield per acre of Bollgard cotton in Andhra Pradesh was 7.33 quintals as opposed to 5.02 for conventional cotton. These figures are testament to the continuing success of GM technology for farmers in the state. How can the activists ignore the fact that the acreage of Bt cotton in Andhra Pradesh increased from 13500 acres in 2003 to 680000 in 2005.

This is in addition to similar quantity of illegal Bt cotton. Do they consider that the farmers who planted more than 1 million acres take to Bt cotton in presumptions, assumptions or false promises! How can an input that provides increased income and improves living condition of the average Andhra Pradesh farmer without putting either the farmer or the environment at risk be termed as bad?

As Dr Norman Borlaug, the Nobel Laureate who was responsible for the Green Revolution along with Dr M.S. Swaminathan, said: "Too many opponents of biotechnology too easily dismiss the many safety and regulatory checks that govern a new agriculture product is brought to the market as worthless. Unfortunately, they willfully choose to emphasise highly unlikely potential risks rather than recognise the years of experience, research and regulatory oversight that govern the safe use of these new technologies."

Let's face it – biotechnology is here to stay. And, we, the farmers know that appropriate biotechnology is not the enemy but the poverty is!

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