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What can BT do for our agriculture?

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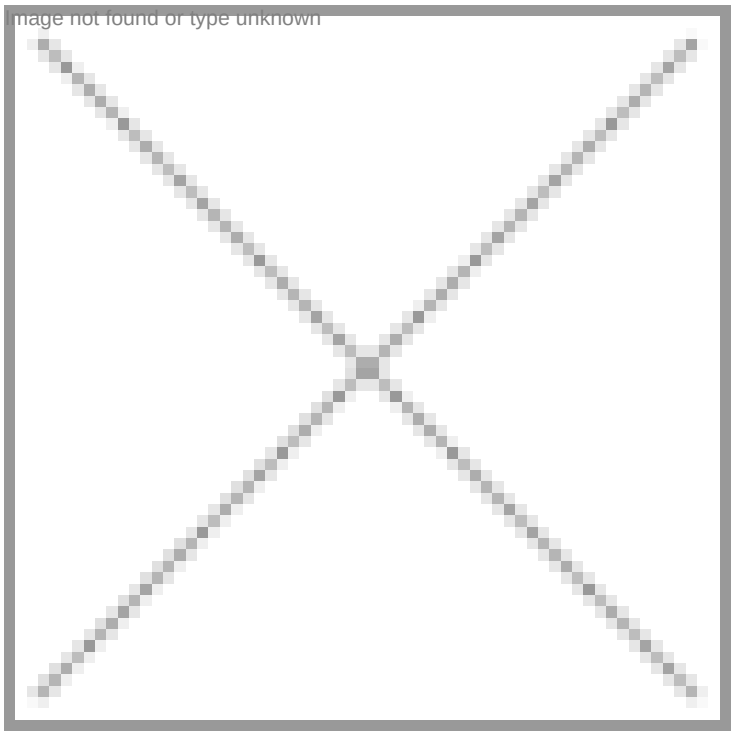

Our country has gone through 10 technological revolutions since independenceâ€”the green revolution, the white revolution, the DNA technology revolution, the drugs revolution, the computer software and information technology revolution, the space revolution, the atomic energy revolution, the defence technology revolution, the institution building revolution and the telecommunication revolution.

The future of the last four of the above revolutions is implicitly linked with biotechnology. It is, therefore, worthwhile looking at what needs to be done to build on our successes in these areas and to plug the loopholes where they exist. This article deals with agriculture that was the target of the green revolution.

Let us first look at our 10 successes in agriculture:

(1) Our production of food materialsâ€”cereals, potato, sugar, pulses, milk, fish, eggs, meat, edible oil and vegetablesâ€”has increased dramatically (in some cases, up to ten- fold) since independence, during which period our population grew by less than three-fold.

(2) There has been a substantial increase in the area under cultivation of high-yielding varieties.

(3) A large number of new varieties of cereals, millets, pulses, oilseeds, fodder crops, sugarcane, tuber crops, vegetables and fruits, totaling nearly 3,000, have been developed, released and used extensively in the last 35 years.

(4) The hybrid technology has been exploited creatively like in the case of millets, cotton, rice, maize and sorghum.

(5) Between 1985 and 1993, we doubled our oilseed production, using a variety of techniques such as exploiting heterosis in mustard.

(6) We have increased our cotton production by a factor of four since independence and developed a number of exotic varieties of cotton, such as Suvin.

(7) Integrated pest-management strategies have been developed and used successfully for cotton, sugarcane, etc.

(8) Systems for conservation and documentation of our plant wealth have been set up. An example would be the National Bureau of Plant Genetic Resources, which has over 200,000 accessions and outstanding facilities.

(9) With over 450 million cattle, buffaloes, sheep, goats, pigs and camels, and well over 300 million poultry, we have one of the largest animal wealth in the world. In the last three decades, the production of broilers has increased from one million to 300 million and we have released a number of new breeds of sheep and cattle.

(10) We are virtually self-sufficient in respect of animal health products today.

Against this background, let us now look at 10 areas where we have missed out and where carefully planned and innovative biotechnology inputs can yield tremendous dividends in the coming years.

(I) While the production of rice and wheat has continued to increase, even in other than traditionally high-producing regions of the country, a host of environmental problems, such as soil degradation, a drop in water tables, contamination of water, micro- nutrient deficiencies, and loss of soil carbon, has begun to surface in many regions. This poses two challenges for biotechnology. First, we must find solutions to these problems. Second, bioinformatics must give us ways and means of including the economic cost of such environmental degradation in agricultural cost and price determination.

(II) While there has been notable success in integrated pest management, it has been so far confined only to a few areas and crops. It must be extended to larger areas and more crops in a carefully planned way.

(III) We must set up an appropriate number of accredited laboratories in the country, both in the public and the private sector, for estimating various chemical and biological contaminants to meet the sanitary and phytosanitary requirements not only for export but also for internal consumption. There is a dearth of such laboratories in the country today.

(IV) The high-yielding varieties, e.g., wheat and rice, which were the basis of the green revolution, required large inputs that the rich farmers only could afford. Biotechnology should allow the development of high-yielding varieties using local genetic material that would not require such large inputs.

(V) Worthwhile original and pioneering research in areas such as post-harvest science and technology, including decentralized storage; pre-harvest and post-harvest physiology, agricultural and veterinary biochemistry, molecular biology, genetics and pathology (including microbiology and virology); and agricultural and veterinary biotechnology, has yet to take root in most of our agricultural institutions. Research in these areas must be encouraged, as that alone would lay the foundations for increase in agricultural productivity and production.

(VI) The socio-economic analysis of the use of energy in agriculture, along with energy-saving mechanisms and strategies for energy management, has not received enough attention at the hands of the scientists in our agricultural research institutions so far. Modern biotechnological approaches should provide us the means to optimize the use of energy in agriculture.

(VII) We need technologies for controlled release of fertilizers and pesticides. For instance, our farmers use nitrogen in large quantities, but with the least efficiency. By doubling the fertilizerâ€“nitrogen use efficiency from 40 percent to 80 percent, the world would not only save about
$11 billion annually but also help
conserve non-renewable resources and improve the environment. Because the non-absorbed nitrogen is not only lost through leaching, nitrification and volatilization, but also leads to environmental contamination such as pollution of ground water. Technologies have already been developed locally for the above purpose but they need to be standardized and improved using modern
biotechnology.

(VIII) The country does not have a policy for sustainable agricultural development that can increase agricultural productivity per unit time, labor and resources used. The resources, labor and time, thus released, could be used for additional employment that would substantially increase the income of farmers/farm-workers. This additional employment could be provided through biotechnology in areas such as food processing, tissue culture (say, of orchids in Arunachal Pradesh) and cultivation and processing of appropriately-selected medicinal plants.

(IX) To ensure that our agriculture remains largely in the hands of our farmers and does not come under the total control of the government-bureaucracy-multinational corporations nexus, it would be essential to invest in R&D of our own in areas such as: exploiting hybrid vigor more vigorously through new scientific approaches than has been done so far; identifying the genetic basis of hybrid vigor and incorporating this information into pure strains, so that the farmer can reuse his seeds with "hybrid vigor"; identifying and using molecular markers for breeding; metabolic engineering (e.g., transferring genes of maize for enzymes such as phosphoenol pyruvate carboxylase/oxygenase and orthophosphate dikinase, into rice for enhancing yield); exploiting the essential natural biodiversity in India; and genetic engineering of plants coupled with stringent risk assessment done in a professional, unbiased, ethical and transparent manner.

(X) We need to invest a great deal more in studying, validating and then utilizing the validated traditional agricultural practices such as water harvesting and organic farming.

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