Transgenic plants and biosafety concerns in India

P. K. Ghosh

The application of genetically modified plants in agriculture would be one of the many scientific inputs to accomplish increased agricultural production. The concerns are the risks and the magnitude of the consequences to the environment. Interestingly after scientifically generating data on safety, certain countries have approved the large-scale use of some transgenic crops. India started its field experiments in open environment using transgenics from 1995. The Government of India set out the rules and regulations for handling the genetically modified organisms (GMOs) which include transgenic plants, in 1989 through its Environment Protection Act, 1986 (EPA). The rules narrate procedures for conducting R&D experiments using GMOs as well as for large-scale applications, using them. Following the clearance under EPA, the transgenic plants are eligible for evaluation in the All India Coordinated Trial (AICT) procedures of the Ministry of Agriculture and Cooperation (MOA) for release by the latter for commercial applications in Indian agriculture.

The protection and preservation of the environment in India is vested upon the government. The Central Government had enacted the environment protection laws from the Ministry of Environment and Forests (MOEF) from time to time to preserve the environment and to protect it from damage. Protection of environment includes assessment of the effects of substances or organisms to animal and plant health besides their effects both on the ecosystem and on the surroundings. In pursuance of the aims and objectives of preserving the environment, the Central Government from the MOEF had promulgated in December 1989 the rules and procedures for the manufacture, import, use, research and release of genetically modified organisms (GMOs) as well as products made by the use of such organisms. These orders were necessary, as the organisms and substances made by the use of genetic engineering hold potential risks to human and the environment. Therefore, without adequately assessing the environmental risks, their use or release into the open environment was considered unsafe and unwise. The intentions of such rules and regulations had never been to hinder or retard the progress of science and technology but to ensure adequately that the use of such products or life forms were safe to the environment, and beneficial to the human beings.

In this paper the biosafety concerns from the use of *transgenic plants* are discussed. Together with this, the existing rules and regulations for using such plants are also briefly enumerated.

Background information and historical highlights

India has realized that to sharply increase the food, feed and fibre production from the current level, there is no escape from use of modern biotechnology. Modern biotechnology includes isolation and purification of target DNA, RNA and protein (enzymes, hormones); cloning and amplification of genes; construction of vectors and hosts; standardization of cell or tissue culture techniques; optimization of downstream processing methods for the handling and stabilization of either the gene products or the GMOs. Genetically modified organisms are the organisms which have been modified through human intervention by recombinant DNA technology, and which are either self-replicating species or which replicate via a host organism, or which have reproductive capabilities. GMOs *exclude* organisms produced by breeding as well as organisms produced by the intraorganism rearrangement of genetic materials by physical methods or by chemical means.

India is spread over 3,287,263 sq km and is the 7th largest country in the world. Its population was 885 million in mid 1993 (16% of global population) which is expected to rise to 1015 million by 2000 AD, and 2530 million by 2050 AD. More agricultural yield is,

---

Views expressed in this paper are those of the author and they do not necessarily express the views of the organization to which he belongs.

P. K. Ghosh is in the Department of Biotechnology, C.G.O. Complex, Lodi Road, New Delhi 110 003, India.

therefore, absolutely necessary for enabling to feed the growing population. The food grains production in India is on the rise; it increased from 176.4 million metric tonnes (mmt) in 1990–91 to 189.8 mmt during 1994–95 (ref. 1). However the increases are almost proportional to the rise in the population and therefore the per capita consumption has remained almost static during the last one decade. In order to maintain the current growth rate in agricultural crops as well as to improve upon the present yields further, various means are to be adopted. Use of modern biotechnology, involving the application of genetically modified plants, would be one of the many scientific inputs to agriculture to accomplish increased production. However, our unfamiliarity with these new inventions has made us more than concerned and alert to deal with them. This situation is true not only in India but also in all the developing countries as well as in the developed nations.

Current biosafety concerns

The main concerns are the right assessment of the magnitude of the consequences from the use of genetically modified plants to the habitat including human and animals, the flora and fauna, and the environment. Certain hereditary traits are targeted for transfer into the transgenic plants by using recombinant DNA technology as discussed subsequently in this text. The concerns[2] are that the chemical herbicide-resistant plants may confer new properties to the near-relative wild plants to make them also resistant to herbicides by transferring the resistant pollens to them and thus may transform them into plants, resistant to the currently used chemical herbicides. This situation would not be controllable by the known chemical herbicides and therefore agricultural production would become more expensive; viral disease-resistant plants may provide opportunities to evolve newer virulent strains of plant viruses by recombination between the viral genes contained in the modified transgenic plants and other infecting viruses against which the target plants are not protected; insect-resistant plants (for example, developed by incorporating specific *Bacillus thuringiensis* (*Bt*) genes, coding for proteins toxic to pests, into plants) may create situations of fast loosing the biopesticide value of the gene products (and therefore the genes),

Table 1. Transgenic crops approved in USA for commercial use

Product	Genetically altered traits	Company	Year of approval and product name, if any
Tomato	Delayed ripening	Calgene	1994, Flaver Savr™
	Delayed ripening	DNA Plant Tech.	1995, Endless Summer™
	Delayed ripening	Monsanto	1995
	Thicker skin and altered pectin content	Zeneca/Petaseed	1995
Cotton	*Bt* gene incorporated plants (ballworm and budworm resistant)	Monsanto	1995, Bollgard™
	Resistant to bromoxynil	Calgene	1995, BXN Cotton™
	Resistant to glyphosate	Monsanto	1996, Round up ready™
	Resistant to sulphomoyl urea	Dupont	1996
Soybean	Resistant to glyphosate	Monsanto	1995, Round up ready™
Potato	*Bt* gene incorporated (Colorado potato beetle resistant)	Monsanto	1995, New Leaf™
	Insect resistant (*Bt* gene incorporated)	Monsanto	1996
Maize	*Bt* gene incorporated (resistant to cornborer)	Ciba-Geigy	1995, Maximizer™
	Resistant glufosinate	Devalb	1996
	Resistant to glufosinate	Agro Evo	1996, Liberty Link™
	Male sterility	Plant Genetic Sys.	1996
	Bt gene incorporated (resistant to cornborer)	Monsanto	1996, Yeild Gard™
	Bt gene incorporated (resistant to cornborer)	Northrup King	1996
Rapeseed/ canola	Altered oil composition (high lauric acid)	Calgene	1995, Laurical™
Squash	Resistant to viruses	Asgrow	1995, Freedom II™

TM = Trademark.

as resistant insects are expected to be developed faster than is surmised, by excessively deploying such transgenic plants in the open environment. Besides, there are also concerns that the use of some of these plants and their products in the human food chain could prove allergic to some people[3].

Current global scenario

Interestingly, after conducting risk assessments and after the evaluation of their hazards by own methods, certain countries have already permitted the use of some transgenic plants in their commercial agriculture. China was the first country to introduce in the early 1990s the viral-resistant tobacco and later the viral-resistant tomato for commercial use[4]. Subsequently in May 1994, Calgene Inc., USA introduced its Flavr Savr™ delayed ripening tomato[2,4] for commercial use. By the end of May 1996, seven transgenic crops involving 10 traits, using 19 processes were approved for commercial use[4] in USA (Table 1).

According to one estimate, up to the end of December 1995, nearly 3650 field trials had been conducted the world over[4], and as already indicated above, several plants have been authorized for commercial exploitation in USA. Information about approval from other countries was not available but it is expected that several approvals might have been accorded in Canada, China, Japan, Australia, Argentina, Mexico and certain European countries. It is estimated by the author that currently in 1996 the world over about 4 million acres of land are used for genetically engineered crops in commercial agriculture and over 75% of the land use for transgenes is in the USA alone followed by Canada (15%) and other countries (10%) (ref. 5).

Countries are permitting the commercial use of transgenic plants obviously because they are satisfied about the biosafety aspects from their use. The approved plants must have also provided additional economic advantage in experimental trials by manifesting the properties imparted upon them through recombinant DNA technology, e.g. herbicide tolerance, increased insect resistance, specific viral disease resistance, etc.; it is too early, however, to be assured with certainty that in every case of large-scale use, the economic advantages are real and sustainable, till the world community uses these plants extensively over long periods. Already concerns have been raised on the utility of *Bt* cotton in USA[6]. However, the current tempo is to maximize the use of transgenic plants at least in certain industrialized countries. The use of transgenic plants with these imparted agronomic traits is therefore anticipated to increase, and may contribute to the economy a global market of between US$ 2 and 3 billion in 2000 AD and $ 6 billion in 2005 AD (ref. 4).

Globally at least 64 different commercially important species of plants have been utilized for incorporating transgenic traits; important among these are maize, soybean, cotton, tomato, potato, alfalfa, petunia, rape/mustard, rice, wheat, beet, barley, Bengal gram, cabbage and tobacco. The traits that have been targeted for genetic acquisitions by the plants could be classified broadly as 6 only (Table 2), and that the tolerance to herbicides head the list[2,4].

Field experiments using transgenics in India

In India, field experiments using transgenic plants began in 1995 when the first permit was issued to M/s Pro Agro Ltd., New Delhi in September 1994, to conduct field trials (in contained and controlled environment) at Gurgaon (Haryana) using transgenic rape seeds (*Brassica juncea*) containing Barstar genes (producing male sterile seeds) and Barnase genes (sterility restorer). Subsequently up to August 1996, permits have been issued for limited field trials using *Bt* gene incorporated tomato and cotton[7]. In these experiments the commercial interests had been to develop improved local varieties from the transgenics (by back crossing etc.). The primary concerns from the regulatory authorities were, however, to find answers to the questions of risks and environmental safety.

Indian rules and regulations on GMOs including transgenic plant varieties

The rules and regulations for the manufacture, use, export, import and storage of genetically engineered organisms have been notified in the official Gazette of the Government of India by the MOEF through their Notification No. 621 dated the 5th December 1989. The notification was issued by the Government by virtue of powers conferred upon it through the EPA, 1986. Any violation and noncompliance including nonreporting of the activities in this area would attract the punitive actions provided under the EPA.

The Department of Biotechnology (DBT) of the Ministry of Science and Technology implements the R&D experiments utilizing GMOs and rDNA products, while the MOEF implements the large-scale commercial use and deployment of these.

Table 2. Genetic transfer of traits in transgenic plants by recombinant DNA technology

- Herbicide tolerance
- Insect resistance
- Viral disease tolerance
- Fungal disease tolerance
- Product quality improvements
- Others (production of speciality metabolites/ chemicals, incorporation of marker genes, stress-resistance properties, etc.)

Indian structure for R&D experiments using GMOs

For R&D experiments, the structures enumerated in the above-mentioned notification are that it directs creation of various committees with set objectives for observing and implementing biosafety guidelines. The biosafety guidelines, available from DBT[8] were prepared by the DBT in 1990 and subsequently revised in 1994. Every organization involved in R&D using GMOs is required to setup its Institutional Biosafety Committee (IBSC), which has a DBT nominee and which is the nodal point for interaction with the Government within the institution/organization. The Review Committee for Genetic Manipulation (RCGM) is a national committee functioning under the DBT and has the functions of reviewing all the approval of ongoing R&D projects on GMOs, undertakes field visits of sites of experimental facilities and issues clearance for import/export of etiologic agents, vectors, germplasms, organelle, etc. needed for experimental working, training and research. Based on the recommendation of the RCGM, trial permits are issued by the DBT. Experiments are monitored by the RCGM besides the IBSC; in addition, the concerned State Biotechnology Co-ordination Committees (SBCC) of each State and the District Level Committees (DLC) of each district are also involved in the inspection and monitoring of the experiments at the field sites.

Indian structure for large-scale applications using GMOs

The Genetic Engineering Approval Committee (GEAC) of the MOEF is the interministerial committee with subject specialists as Members, and is the Competent Authority for any large-scale use of GMOs. The MOEF would issue the authorization to applicants on the basis of approvals accorded by the GEAC. As in the R&D trials, the large-scale use authorized by the GEAC also involves the watch on field applications of GMOs by the SBCCs and the DLCs. The GEAC would also involve the user Ministries as well as the other regulatory authorities (for example, for Drugs and Pharmaceuticals, the Directorate General of Health Services are consulted; for other items the concerned administrative agencies are consulted) before authorizing any commercial use of GMOs and rDNA products. Eventually, it is the concerned Administrative Ministries which take over after the clearance under EPA is accorded by the MOEF.

Field trial methods using transgenic plants

Planned field experiments using transgenic plants are permitted only after a stepwise evaluation of the developmental process from lab scale to the growth chambers and greenhouse conditions are thoroughly evaluated. The data for evaluation may be generated in India or elsewhere. The documentation requires full characterization and description including the sequence of the target gene and its promoter sequence as well as the regulatory mechanism utilized in the expression casette, diagram of the expression casette to describe fully the marker genes used, the description of the restriction sites related to specific endonuclease, the cell lines used for shuttling and amplification of the expression casette, the method of construction of the target gene along with all the sequences added or deleted, the extent of target gene amplification into the host genome and the description of the amino acids sequence being transcribed by the target gene as well as the marker genes. Lab data are insisted upon to prove beyond doubt that the translated gene products as well as the plants are safe to the environment and the human beings. If such data are not available, these are asked for to be generated.

Certain criteria are insisted upon which are to be followed while conducting field trials in small scale (R&D experiments) or in large-scale as indicated below.

1. To maintain at least the minimum isolation distance recommended for raising 'Foundation Seeds' all around the transgenic plants. Within the isolation distances noncompatible crops could be grown. For the details of the isolation distances for various crops, the publication of the Central Seed Certification Board of the Department of Agriculture and Cooperation, MOA for foundation seeds is to be followed[9].

2. Beyond the isolation distance, a few rows of the nontransgenic plants of the same crop to serve as a pollen trap may be grown.

3. In order to measure the distance of pollen escape from the target plants, within the isolation distance at intervals of 1 to 5 m nontransgenic plants can be grown; the seeds set at different isolation distances are then collected individually and separately aggregated, examined for the transgenic traits and the marker gene traits to work out and assess the extent and the distance of pollen transfer/flow from the target experimental sites.

4. Safety tests include the generation of data on the elucidation of genetic markers, host range requirements for vegetative growth, persistence and stability in small plots and experimental field trials for at least two years.

5. All the vegetative plants and left over seeds are to be destroyed by burning after the experiments.

6. The land may be left fallow next year after the experiments are over and the plants, if any, emerging in the soil from the seeds of last year may be destroyed.

7. The experimental field may be visited by the company authorized personnel only, and all records of visits are to be maintained.

8. Full account of transgenic seeds produced are to

be kept and no transgenic seeds be transacted or further propagated without authorization.

Discussion

The decisions for the application of transgenic plants in commercial agriculture are intimately connected with the concerns of safety among all cross sections of society. Decreased familiarity about the risks associated with their use aggravates the situation further. The concerns assume great significance particularly for applications in agriculture, as the products would be parts of human and animal food chain. It is for these primary reasons that the questions of safety from the application of transgenic plants are being passionately posed by different countries in different fora.

In order to be assured about all aspects of safety from the use of new technologies, it is surmised that certain steps taken sequentially, and answers found on sound step-by-step scientific assessment would resolve all the issues concerning safety[10]. It is mentioned in this connection that steps should be taken gradually and steadily without showing an iota of hurry and rush to reinstate the process of confidence building among all sectors of human community. In all initial assessments in the open environment, contained experiments must first be carried out. The purpose of containment is to ensure fool-proof methods of maintaining control over the spread of the GMOs in the open environment. Further, it is to reduce the exposure of GMOs to the personnel handling them, particularly in cases where the GMOs are associated with any human allergens. The following steps are logical, for which answers from different angles should be found in the registration document, based on which it would be possible to decide about safety and associated risks.

a) To systematically *identify the hazards* from the use of transgenic plants.
b) To *assess the risks* from each identified hazard by mounting convincing experiments and by collecting scientifically convincing data.
c) To *manage the risks* by applying logically valid strategies which would, inter-alia, include methods and procedures for minimizing risks.

In order to systematically identify the hazards and to assess the risks, information on the plants with transgenic traits should be generated on the following aspects.

1. Characteristics of the *donor organisms* providing the target nucleic acids. These may include the following:
a) Name of the donor organism with its identification characteristics with relevant reference to published information, if any.
b) Pathogenicity and toxicity characteristics to plants and animals.
c) Allergenicity characteristics to human along with identification of the allergenic substances, wherever possible.
d) The geographical origin of the organism, its distribution pattern and survival mechanism.
e) The method of transfer of its genetic materials to other organisms.
2. Characteristics of the *vectors* used: These may include the following:
a) The origin, identity and habitat of the vectors used.
b) The sequence, frequency of mobilization, specificity and marker genes if any, present in the vectors.
c) The abilities of the vectors to get established in other hosts; the hosts are also to be specified.
3. Characteristics of the *transgenic inserts*: These may include the following:
a) The specific functions coded by the inserted nucleic acid stretches including the marker gene inserts.
b) The expression of the nucleic acid products and their activities/properties.
c) The toxicity of the expression products on the host plant, if any.
d) The toxicity and allergenicity of the nucleic acid products to human and animals.
4. Characteristics of the *transgenic plants*: These may include the following:
a) Methods of detection of the transgenic plant in the environment.
b) Methods of detection and characterization of the escaped transgenic traits in the environment.
c) Toxicity and pathogenicity of the transgenic plants and their fruits to other plants in the ecosystem and the environment.
d) Possibility of and the extent of transgenic pollen escape and pollen transfer to wild near relatives, and the consequences to the environment.
e) Pathogenicity, toxicity and allergenicity of the transgenic plants and their fruits to human and animals.
f) Changes in the soil microflora due to cultivation of transgenic plants.

Information on many of the above questions may not yet be available. Therefore appropriate new experiments would have to be designed to gather data. Unfortunately, universal model experiments have not yet been designed for collecting data to reply to all the questions posed above. In seemingly controversial situations, the next best alternatives are to be found out after considerable scientific debate in the country. As regards generating information on toxicity and allergenicity, standard protocols are to be devised for collecting data utilizing small adult lab animals. The toxicity data should include acute as well as chronic toxicity studies; in doubtful situations genotoxicity, teratogenicity, neurotoxicity and immunotoxicity data should also be generated in small lab animals. Chronic toxicity data may also be generated

using large locally available mammals like goats or sheeps or cows or dogs for about 8 to 12 months, but not less than 3 months. Utility of data from these animals may be debated for reasons of nonuniformity of genetic makeup of these animals as they are outbred, they are ruminants and are therefore more distantly related to human species than monkeys are. It is surmised, however, that the feeding data generated on these animals found in local environment would help in the resolution of local concerns about the risks from the long-term use of transgenic plants, entering directly or indirectly into the human food chain. Safety information generated on animals abundantly available in local environment and closely linked with human habitat is more ensuring to human than the extrapolated assurances drawn from data on distantly related varieties of small lab animals. Similarly, feeding data generated on some common avian species like sparrows, parrots or pigeons, which are found in the local ecosystem, is expected to put to rest the anticipated fear of creation of disturbances in the environment from the use of GMOs.

Once the questions regarding identifying the hazards and assessing the risks from various angles are resolved, it would be easier to *manage the risks* by applying logically valid strategies. The strategies are to be commensurate with the risks identified. The risk-management strategies for the release of transgenic plants may take into account the following:

a) Spacial separation for isolation, for preventing reproduction/fertilization and seed setting.
b) Biological prevention of flowering by making use of sterility properties, etc.
c) Human intervention for the removal of reproductive structures of flowers.
d) Controlling the reproductive structures of transgenic plants like the seeds and the plant propagules from unaccounted spread.
e) Controlling and destroying volunteer plants from the experimental field.
f) To take into account the proximity to human activity in case the transgenic plants have allergenic properties to human and animals.
g) Appropriate training of field personnel responsible for handling the transgenic plants.
h) Plans for handling unexpected events.
i) Documentation of previous published information, if any, including any documented evidence of effects of release to ecosystem.

For the assessment of hazards and risks, and for the management of risks the recombinant DNA safety guidelines of the DBT[8] should be strictly adhered to. In order to enable the GEAC of the Government of India in the MOEF about the proper assessment of risks and hazards from the use of transgenic plants before permitting their large-scale release, information on the lines discussed above is required to be submitted in a format which was devised for the purpose[11] by the government some years ago. The format needs to be updated.

Based on the assessment of the above information, prepared by the applicant in the form of a document which could be called the Registration Document, the GEAC would decide if clearance for commercial use would be permitted for specific transgenic plants. Up to the present time, however, no transgenic plant variety has yet been cleared by the Government of India for large-scale commercial use.

The GEAC clearance is only from the environmental angle under the EPA. Following the GEAC clearance, the applicants are to seek the clearance of the MOA, who in turn would then install the procedures of AICT through the system of Indian Council of Agricultural Research (ICAR), New Delhi. The final clearance of transgenic agricultural crops is accorded by the MOA through its well-established wing of assessment. Figure 1 shows schematically how a transgenic variety is to be eventually cleared by the Government for extensive field use, starting from research stage. It could be seen therefrom that the GEAC may, based on the information generated elsewhere by the applicant, or through the RCGM mechanism in India, accord approval to the applicant to proceed further for initiating the All India Coordinated Trial (AICT).

The experience gathered so far in India is indicative of a minimum time requirement of 3 years for generating information for submission to the GEAC for environmental clearances of GMOs, if proceeded through the IBSC and the RCGM mechanisms. Subsequently, the AICT would also take 1 to 3 years before enough data is generated for the MOA to enable the latter to decide on varietal clearance. In other words, a minimum of 4 to 6 years are required for transgenic plants to get entry into the Indian Commercial Agriculture.

Concluding remarks

The hazards and risks are to be assessed based on up-to-date current knowledge on the transgenic plants. The common elements and principles drawn from the experiences of other countries would go a long way in our understanding and in confidence building, although in certain situations experiments based on local conditions would have to be devised and local data generated. It has to be kept in mind that unfamiliarity with transgenics would not necessarily mean that they are *per se* unsafe. Our monitoring of the transgenics shall have to be intensified from simple visits and simple in-place observations of transgenic plants in fields by the expert team, to designing extensive research programmes to seek answers to specific safety questions. This would also need to broaden the knowledge base of the expert

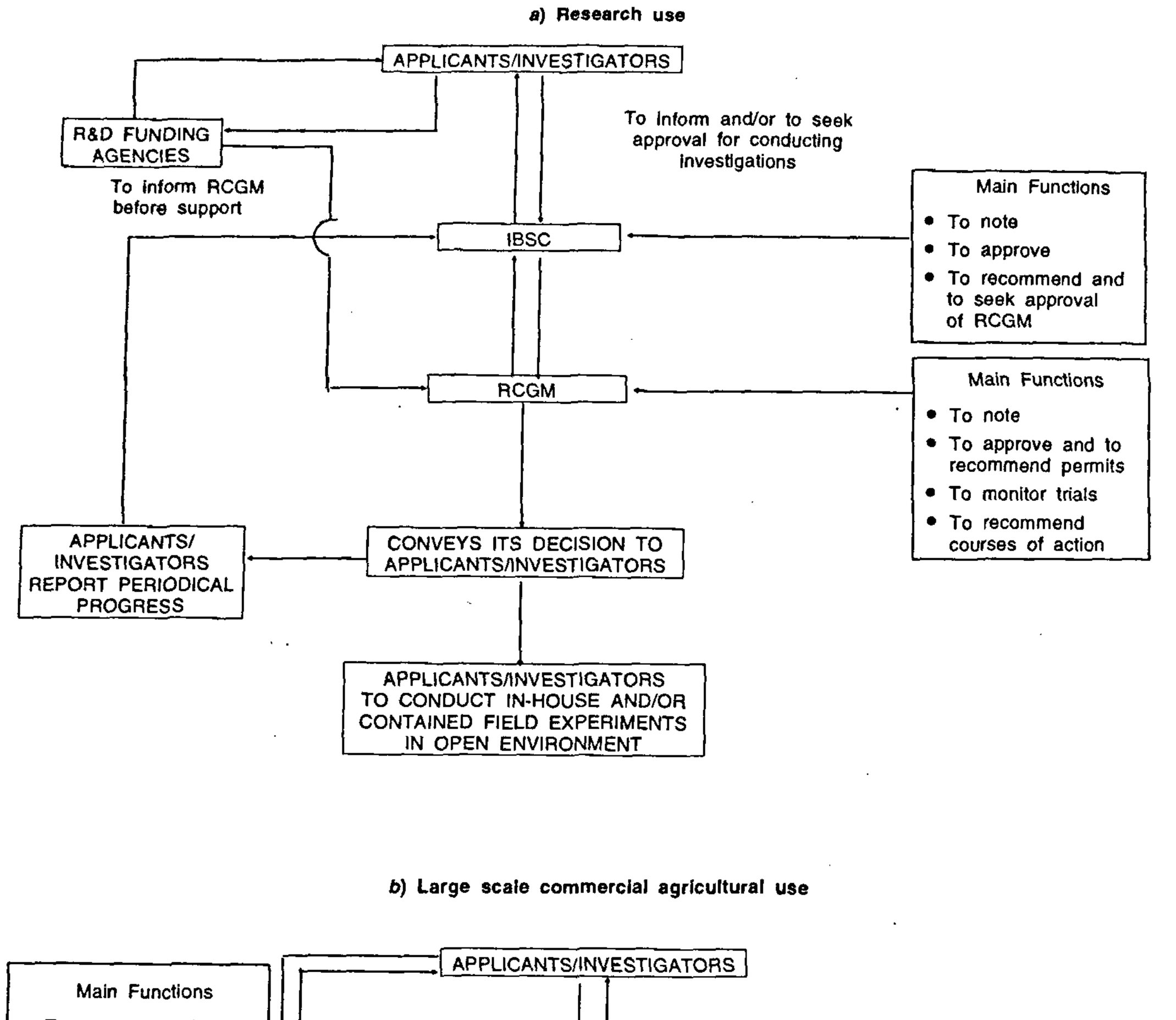

Figure 1. Handling of transgenic plant varieties for clearance by the Government of India (*a*), for research use and (*b*), for applications commercial agriculture.

breeders, the plant molecular biologists and above all the science managers and the authorities. The technological area being new, and the world knowledge being yet inadequate, several readjustments and redesigning of strategies to suit local conditions may be required. The future will tell how the countries would go about in this vital new technology area. In the meantime, keeping in view the global developments, specially in the developed world, it is being felt that precious time is running out fast from the hands of many developing countries including India. There has to be a greater sense of urgency in order to develop local capability to enable the generation of right information and to ensure the faster assessments of risks and hazards, and finally to decide on commercial applications quicker. In deciding commercial applications however, a cautious approach would be more desirable than is presently surmised globally in certain countries. A cautious approach is not to foster the creation of unscientific new barriers against the use of GMOs, but to bring in more transparency in their introduction in the open environment. From Indian experience, it appears that the first transgenic plant may get approved for use in commercial agriculture not before 1998.

1. Prabhu, N., *The Economic Times*, Delhi dated 5.11.1995, Special Report, p. 7.
2. Ghosh, P. K., *J. Sci. Ind. Res.*, 1995, **54**, 217–230.
3. *Biosafety: Scientific Findings and Elements of a Protocol*, Report of the Independent Group of Scientific and Legal Experts on Biosafety, Third World Network, Malaysia, July 1996, p. 18.
4. James, C. and Kratiger, A. F., in *Global Review of the Field Testing and Commercialisation of Transgenic Plants, 1986 to 1995: The First Decade of Crop Biotechnology*, 1996, ISAAA Briefs No. 1, ISAAA, Ithaca, NY, pp. 1–31 (adapted from this source).
5. Based on personal discussion with several experts from different countries including USA, Canada, Argentina, Brazil, China, Australia, Japan, UK, France and certain African countries. In USA nearly 3.11 million acres were used, of which 1.8 million was for cotton, 1 million for soybean and 0.31 million for maize, tomato and potato; in Canada out of nearly 0.58 million acres used, 0.55 million was for canola and 0.03 million for potato; in other countries, the usage was Argentina (0.05 million for soybean), Mexico (0.01 million for corn), China (0.16 million for tomato, tobacco and cotton), Australia (0.075 million for cotton) and about 0.015 million in the rest of the world including Europe and Japan.
6. Fox, J. L., *Nature Biotechnology*, 1996, **14**, 1070.
7. *Annual Report (1995–96)*, Department of Biotechnology, New Delhi, 1996, pp. 110–111.
8. *Recombinant DNA Safety Guidelines of the Department of Biotechnology*, Ministry of Science & Technology, New Delhi, May 1994.
9. Tunwar, N. S. and Singh, S. V., in *Indian Minimum Seed Certification Standards*, The Central Seed Certification Board, Department of Agriculture Cooperation, New Delhi, July 1988.
10. *UNEP International Technical Guidelines for Safety in Biotechnology*, Based on Global Consultation of Government designated Experts, held in Cairo, Egypt during Dec. 11–14, UNEP, Kenya, 1995, pp. 1–31.
11. Ghosh, P. K., in *Biotech Industry Guide*, Biotech Consortium India Ltd., New Delhi, 1995, pp. 334–340.