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Chapter 4: Use of GMOs Under Containment, Confined and Limited Field Trials and Post-Release Monitoring of GMOs

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Introduction

The Genetically Modified Organisms (GMOs) in the plant world are those plants which are produced in the laboratory by incorporating into the native DNA of the plant, a small DNA portion carrying a gene that is foreign to the native species. This foreign gene is a recombinant DNA construct (rDNA) with all other regulatory switches to help the foreign gene express in its new genetic environment. This expression can be different from its original expression to the extent of expression which may make the GMO overproduce, underproduce, differently produce or not produce the protein product it is known to produce. But, when rDNA is produced it is within the confines of a highly specialized laboratory with skilled scientists and people handling the product who are generally trained to deal with the positive output as well as the negative ones and the unperceived consequences which comprise the major amount of risk involved. However, when it gets out of the laboratory, the element of risk associated with it passes into the hands of those who may not be associated with the technology or who would not understand the technology at all. The commercial activities about the technology makes the exposure still wider confounded with the risk involved in its release into an environment.

The direct use of DNA either from unrelated organisms or from synthetic sources through molecular biological techniques to manipulate the genetic make-up of organisms has provided a large number of alternative strategies in making agriculture productive. The potential is vast beyond the realms of the conventional (though scientific) approaches the breeders have been following ever since agriculture was domesticated as source of sustenance and livelihood.

The genetically modified organism (GMO, also referred to as living modified organism or LMO or popularly, transgenic organism) follows the same evolution cycle like that followed by any other technology that a evolving society invents, develops, produces, markets a commodity followed by R & D by the producer involving the inventor after consumer feed-back. In our context, GMO mostly concerns the transgenic crops to a large extent and micro-organisms to a lesser extent.

Ever since the discovery of the scientific fact that genes from a totally unrelated organism (virus, bacterium, plants or animals) to plant in mid 1980s came to light, when a gene from Bacillus thuringiensis was cloned into a plasmid vector and transferred into tobacco (a process known as genetic engineering), the brightness of the discovery enlightened scientists from public and private domains alike to the limitless scope the technology possessed. Since then,

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genetic engineering of plants has gone from a new and largely untested technique to a common agricultural phenomenon in most developed countries and some developing countries like China and India.

The first field trial of a GM organism went ahead in 1986. Frostban was a spray containing genetically modified bacteria. In the trials, Frostban was sprayed over a strawberry crop to protect them from frost damage. Frostban was designed to stop the growth of other bacteria that catalyse the formation of ice. Frostban was tested at a site in Brentwood, California. But this open-air experiment didn't please the local population, who formed a protest group called The Strawberry Liberation Front – the first pressure group opposed to genetic modification. But in the US, opposition to GM agriculture was short-lived and small-scale. In 1993 the US Food and Drug Administration declared GM food was 'not inherently dangerous', clearing the way for biotech companies to begin marketing modified seed.

Within a decade after the first of the commercial transgenic crops became available to farmers to cultivate the area, more than 70 million acres of transgenic crops are grown in 2002. In the case of crops such as soybean, cotton and canola put together, nearly 60% of the cultivars are transgenic in origin. Such has been the pace with which commercial agriculture adopted the new technology. Of these crops under transgenics, about 40% are those which carry the *Bt* toxin (crystal protein gene – *cry* in its variant forms) that provides the crop an ability to kill the lepidopteran (sap-sucking) insects, followed by about 25% carrying the herbicide resistance genes (RR gene) which can withstand a particular type of herbicide while the weeds cannot. The other transgenics are those that have been given resistance to particular viruses by having a gene from the virus inserted into their DNA. In nutshell, the transgenics have arrived and are more likely to stay than otherwise, despite the disfavors among consumers and ecological concerns of nature watching scientists.

Rationale for post-release monitoring*:* In 1995, the Conference of the Parties (COP) to the Convention on Biological Diversity set up an open-ended ad hoc Working Group on Biosafety to draft a protocol. After several years of talks, the COP adopted the Cartagena Protocol on Biosafety in Montreal on 29 January 2000. The Protocol is named to honour the city of Cartagena, Colombia, which had hosted the COP's first extraordinary meeting intended to finalize and adopt the Protocol in 1999.The Biosafety Protocol was finally adopted in January 2000 with a stated aim to "contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements" . The need for a protocol to be followed before and after an introduction of a GMO came into focus as it was also realized that there could be unintended hazards and risks from the use of GMOs and products thereof, if the new technology was not properly assessed before use. A gene construct comprising a host compatible promoter, a gene of interest and a terminator sequence or a polyadenylation

sequence is integrated in a stable manner into the genome of the organism/cell line of the target gene to be expressed and stably inherited. A genetically modified (GM) organism can be safe but this can be unsafe too. This will depend upon the trans-genes, the host organism and the environment where the GMO is being tested. In case of GM plants, in laboratory experiment, viral disease resistant transgenic plants have given rise to newer viruses by recombination. Transgenic rape seed plants containing bar genes transferred the transgenic trait to near relatives of Brassica spp. Insect resistant Bt plants coding for specific Bt proteins developed bt protein resistant insects in laboratory experiments. Transgenic soybean genetically modified to increase its sulfur containing amino acids by incorporating Brazillian nut 2S gene was allergenic to serum of people who were allergenic to Brazillian nut 2S protein. Potatoes genetically modified with specific lectin genes protected attack from insects but such portatoes were not safe to rodents when they were fed with such potatoes. The transgenic pollens of corn coding for Bt proteins killed the monarch butterfly larvae when they were forcibly fed with such pollens. It is expected that transgenic pollens coding for Bt porteins would affect the silkworm larvae, as these are insects that are susceptible to Bt proteins. There are examples of microoganisms, especially genetically modified viruses that turned virulent after modification.

Monitoring plays a central role in environmental risk assessment and management and is undertaken to gain continuous or periodic information about aspects of an intention before it starts, during its lifetime and after its completion. Information generated from monitoring programmes is integrated into environmental risk assessment and management in various ways:

- as the baseline against which to compare actual and predicted impacts;
- as an input to models, forecasts and quantification stages;
- to provide information to feed back into the risk assessment in an iterative process;
- to confirm that risk assessments and management options are meeting their desired aims; and
- as an alert mechanism if adverse impacts are found

The magnifying effect any possible post-release disaster may lead us to is not something that has not happened with the non-GMOs in the past. The effect could be as drastic as that is perceived as that can be caused due to the commercialization of a GM crop. Ever since the occurrence of such epidemics and ecological calamities, scientists have been very cautious by monitoring the varietal composition in geographical area, monitoring releases through multi-locational trials advising breeding communities to ensure diversity in the genotypic composition of the material being released for commercial cultivation. Organized pre-commercial release testing under monitored experimental conditions is a pre-requisite at least for three years, which actually is nothing but a post-release monitoring of the material in a given target environment.

History, the guide: Thus, obviously, post-release monitoring is not new to organized agriculture. Agricultural scientists have been constantly monitoring crop ecologies for spotting any new pest, pathogen or any reduction/invasion of naturally existing vegetation in the region. This type of monitoring is also assisted by farmers who notice and observe anything that is unusual. Apart from such ad-hoc monitoring which often ended up in a research experimentation on created conditions, the recorded abnormal effects observed also led to the development of a scientific approach to systematic monitoring where collection of data to build information databank on the crop. This began from public investments because, each of such abnormalities observed had consequences of public funds required in their amelioration. Quickly, the governments realized the value of such data collection on crop plants as the sole authenticated information that could distinguish the "rumour" from "fact". This also proved valuable in policy formulation, which in turn led to directed development which could be properly planned and executed.

The same experience works good to necessitate the monitoring of GM crops which have the novelty their predecessors never possessed, and an intensive investment, the sort of which was never seen before, once the crops are released in an environment. The proportion of investment in the development of GMOs also exceeds the search for novelty which the mutation based crop breeding involved in the early decades of 1950s-1970s, world over. Obvious reason is the fact that the conventional breeding is largely an imprecise process because of the involved unknown number of genes, selection for several generations done not only to bring in desired characters but also eliminate the undesirable gene combinations that might have deleterious effects. This lengthy, winding process measured through several eyes, hands, locations and seasons has basically contributed to the safe history and low risk image of conventional plant breeding unlike the molecular breeding involving the GMOs .

Present, in the real world of GMOs: The first concerns which consolidated the indispensability of post-release monitoring of the GMOs came with the observations on observed and/or perceived occurrence of the death of the Monarch butterflies in the vicinity of Bt maize transgenics in the late 1990s (Jesse and Obrycki, 2000) and the movement of the herbicide resistant transgene into related wild weedy species in the case of canola in US and Canada. That this scare is widely recognized as unfounded extrapolation from limited research should give us a hope in the wake of several such "uninformed or ill-informed" perceptions being aired by opponents of this most useful technology.

With the developing countries like China and India making inroads into developing and cultivating GM crops, the exposure to a different production system than that exists in North American countries like the prairies and vast agricultural stretches. In the developing countries, the size of holdings will be much smaller which means potential mosaic of same crop but different cultivars and same cultivars from different seed sources in a concentrated sympatric existence. Needless to say, the emphasis on the concerns on the ill-effects as a consequence of release of the GM into an environment is of extremely relevant to us in this

part of the world. The value of monitoring that uses the Precautionary Principle into consideration is obvious when we look into the cases such as the Brazil nut case in soybean. In 1997, US scientists inserted a gene from a Brazil nut into soybeans to make them more nutritious. But the gene also passed on the property of nuts that causes allergies in people. Luckily, the risk was perceived, assessed, analyzed and monitored. The monitoring detected the allergy transferred in about 75% of the events being tested and the project was abandoned. One is not really aware if such cases of allergenic responses have been passed into cultivated varieties from wild species in conventional transfers done by breeders. Under no circumstances we can presume that such a potential never existed in conventional mode of gene transfers through interspecific hybridization as these were never monitored for such traits!

Monitoring GMOs Under Containment

The activity of monitoring the GMOs under containment specifically refers to the physical structure of the containment specificity seen together with the degree of risk involved with the specific GMO. Yet, there is a need to consider both general inspection of the facility for compliance to GM containment needs irrespective of the extent of risk involved in any particular GMO being monitored. This is simply because, containment facilities cannot be built for each GMO and therefore, the basic structure of the containment facility must meet minimum standards set for each category of risk. With the basic minimum structure in place and met with in general, the monitoring should then be specific to the transgenic event involved. Thus, the "What should be structurally in place" for a particular level of risk classification becomes the check list to be verified for its compliance and proper commissioning. It is suggested therefore, that the following should be taken as standard to be met for clearing the execution of the experiment under containment as "conducted in compliance to biosafety regulation" by the monitoring agency.

Monitoring GM Plants Under Containment

The GM plants need to be first classified into groups based on the extent of safety the material has to be accorded in terms of hazard to human health, crop ecology and environment concerned for effective monitoring of the contained use being applied. The monitoring team should always consider the specific categories for appropriate monitoring indicators of generic nature apart from those specific to the event or trait while recommending the containment trial or evaluating the experiment for furthering to field trial.

As an example, the categories of transgenic plants are as follows:

CATEGORY I

This category includes routine cloning of defined genes, defined non-coding stretches of DNA and open reading frames in defined genes in E_ coli or other bacterial and fungal hosts which are GENERALLY CONSIDERED AS SAFE (GAS) to human, animals and plants. A list of such microorganisms will be prepared by the RCGM and shall be made available to the RI. on request.

This category involves experiments in the lab in contained environment and includes the following.

i. Routine cloning of defined DNA fragments of microbial, animal and plant origin in GRAS organisms.
ii. Transfer of defined cloned genes into Agrobacterium;
iii. Use of defined reporter genes to study transient expression in plant cells to study genetic transformation conditions;
iv. Molecular analysis of transgenic plants grown in-vitro.

Category I experiment need only intimation to the Institutional Biosafety committee the prescribed proforma.

CATEGORY II

This category includes lab and green house/net house experiments in contained environment where defined DNA fragments non-pathogenic to human and animals are used for genetic transformation of plants, both model species and crop species and the plants are grown in green house/net house for molecular and phenotypic evaluation.

This category includes the experiments described below:

i. Transgenics with constitutive, tissue specific and chimeric promoters used for experimenting expression of defined DNA fragments
ii. Marker genes extensively used in genetic transformation of plants in lab and green house/net house experiments.
iii. Lab and green house/net house experiments with plants with herbicide resistance conferring genes;
iv. Lab and green house/net house experiments with plants using heterologous genes which confer resistance to biotic and abiotic stresses (i.e. genes like chalcone synthase, heat shock proteins, chitinase, protease inhibitors etc.);
v. Lab and green house/net house experiments with genes from plants, animals and micrcúial sources that would confer resistance to plant pathogens.
vi. Lab and green house/net house experiments on transgenics with genes for the production of antibodies.

vii. Green house/net house experiments with transgenics with transposable elements for gene tagging in crop species or model species.

In India, the permission for performing Category II experiments will be provided by IBSC. The decision of the IBSC would be intimated to a broad based committee that is independent of the Institution which developed the transgenic (in India, RCGM) before execution of the experiments and RCGM would put this information on record.

CATEGORY III & ABOVE

This category pertains to high risk experiments where the escape of transgenic traits into the open environment could cause significant alterations in the biosphere, the ecosystem, the plants and animals by dispersing new genetic traits, the effects of which can not be judged precisely. All experiments conducted in green house and open field conditions not belonging to the above Category I and Category II types, would fall under Category III risks. Such experiments could be conducted only after clearance from RCGM and notified by the Department of Biotechnology.

Based on the category of risk and nature of the transgene/s, the containments are physically built with varying degrees of Biosafety levels, lowest being BL1 and highest Biosafety at BL4 levels. Most of the transgenic plants can be safely experimented within BL-1 and BL -2 when they fall in the category of I and II. Those plants or microbes in category I and most plant analyses that do not involve any reproductive phase analysis of plants or subjectivity to spread through insects (such as viruses) can be effectively managed in BL1.

The brief descriptions of the greenhouses rated to BL1-BL4 are as follows (NIH, 1999):

Biosafety Level 1 (BL 1): Biosafety level is suitable for work involving agents of unknown or minimal hazard to laboratory personnel and the environment. The work is conducted on open bench tops. Special containment equipment is not required or generally used. The greenhouse floor need not necessarily be impervious. But the walk ways must be of impervious material.

Biosafety Level 2 (BL 2): The access to the greenhouse is restricted to individuals directly involved with the experiments in progress. Decontamination of runoff water is not necessarily required. The floor of wall of the greenhouse should be periodically treated to eliminate any entrapped organisms in the gravel or grooves. The floor is composed of an impervious material. Soil beds are acceptable unless propagules of experimental organisms are readily disseminated through soil. Windows and other openings in the walls and roof of the greenhouse facility may be open for ventilation as needed for proper operation and do not require any barrier against pollen or microbes. But screens are required to prevent insects, birds and animals.

Biosafety Level 3 (BL 3): Prior to entering the greenhouse, the personnel shall be required to pass through a set of two self closing locking doors. Disposable clothing like aprons shall be worn before entering into the experimental area. The hallway leading to the green house is

also a part of the containment. The need is to maintain negative pressure. The floor should be composed of concrete or other impervious material with a provision for collection and decontamination of run off. Windows shall be sealed and all glazing shall be resistant to breakage. The plumbing and utilities need to be sealed. The supply and exhaust airflow shall be interlocked to assure inward or zero airflow at all times.

Biosafety level 4 (BL 4): BL 4 is known as maximum containment level. The personnel shall enter the greenhouse facility only through the clothing change and shower rooms and shall shower each time they leave the facility. An outer and inner change rooms separated by a shower shall be provided for personnel entering and exiting the facility. Windows shall be sealed to permit fumigation. Every plant material leaving the green house has to be autoclaved. The material shall not be brought through the change rooms but through ventilated airlock. The supply and exhaust airflow shall be interlocked to assure inward air flow at all times. HEPA filters shall be provided to treat air supplied to the facility. All liquid effluents shall be decontaminated. Other biological containment options like cover reproductive structures, remove the same if seed not required and ensure that plants flower at that time when cross fertile plants are not flowering within the normal pollen dispersal range of the experimental plant or ensure that cross fertile plants are not growing within the known dispersal range.

Monitoring indicators

The monitoring indicators basically have to be developed on a case by case basis with reference to the gene involved, the category of risk as well as the Biosafety level the material is contained in. The application for approval by the Institutional Biosafety committee should contain the details on which basis the IBSC grants the permit under intimation to the next higher regulatory body, the RCGM which may not involve any one on its body from the Institution, whereas, two of the representatives in the IBSC will necessarily be from the Biotechnology Department, in Indian context. This removes any bias or institutional priority which may lead to Biosafety oversight.

It is required to fill the form with full information the monitoring team can utilize for generating a checklist that identifies the oversight if any in following the Biosafety regulations. The questionnaire should therefore be related to the agreement to the prescribed standards mentioned in the table. All the stipulated regulations if are followed will in general meet the containment characteristics which in other words would suggest that the experimentation has been contained. However, precaution is to be taken to include the items related to the training available with the users and the managers of the containment facility.

The Monitoring team can develop a series of questions which relate to adherence of maintenance of protocols for greenhouse maintenance at appropriate level when they contain the transgenic plants or plants tested with transgenic microbes. Complete details of protocols to be followed in a greenhouse maintenance including biosafety aspects that are followed in

the greenhouse at the National Phytotron Facility, in IARI, New Delhi are presented in a schedule-wise list of activities by Romer et al. 2000. The summary of the schedules which are appropriate are detailed in Table 2. Activities need to be monitored by the members of the IBSC or an institutional committee so that containment is ensured.

Containment of Genetically Modified Animals

The very first activity the monitoring agency should consider in the case of GM animal based activities is whether the experimenter, Institution or the Organization has the approval of the LOCAL ANIMAL ETHICS COMMITTEE OR ANIMAL WELFARE COMMITTEE for dealing with the animal species and the attempted trait modification. If this is not there, then however important the research or objective is, should be kept in abeyance. The Biosafety cannot overlook the ethical consideration and animal welfare.

The current level of transgenic developments in animals is generically divisible into two levels synonymous with the BL1 and BL2 levels of the plants. There are requirements for higher category of biosafety which are not with reference to the GM status of the animals, but with the hazardous products being developed from these like vaccines, sera, antibodies, etc. For our purposes restricted to the GM animals, the two categories are,

1. Containment A representing the minimum, or basic, recommended level of containment consistent with good practice.
2. Containment B represents a higher category of containment.

GM Animal Containment A

Containment A is recommended for GM animals which exhibit any of the following traits or properties:

- they are incapable of surviving in the environment in the location or
- they have limited ability to transfer genetic material to local animal species, or
- female farm animals which are easily recalled, for example transgenic sheep, or
- the genetic modification does not increase the level of risk to human health or the
- environment above that of the non-modified parental organisms;

  and
- the animals have not been inoculated with GMMs or other pathogens.

In all cases, Containment A is only suitable if the risk assessment, taking into account the animal, modification, activity and containment, is shown to be low or effectively zero. Examples of the types of GM animals for which this containment is appropriate are likely to include "knockout" mice; "nude" mice; tropical fish that are unlikely to survive or large mammals expressing pharmacologically active proteins in their milk, etc.

The recommended procedures to be followed in Containment A

The following procedures and containment are recommended as minimum standards of good practice. They will need to be supplemented by measures for specific animal types (Annex I). The specific measures must be chosen in accordance with the risk assessment.

Minimum/baseline measures for Containment A

- The containment areas for vertebrates should be in accordance with the Animal Ethics Committee or Animal Welfare Committee.
- Animals should be kept in appropriate containment, such as in animal rooms, or securely fenced areas, to minimize the possibility of accidental escape or theft as per the animal type and risk involved with the trait.
- All potential routes of escape should be identified, and appropriate measures put in place to prevent egress. Mesh covering should be used to cover drains. The mesh size should be suitable to prevent the smallest animals escaping.
- The containment area should be kept locked, where appropriate, and monitored at frequent intervals.
- Animal barriers should be placed on exits from animal rooms to corridor areas when rooms or cages are being cleaned.
- A barrier should separate male and female animals, unless reproductive studies are part of the experiment, or unless other measures are taken to avoid sexual reproduction. Animals should be separated as soon as possible after weaning. Where it is difficult to determine the sex of an animal until sexual maturity, this should be carried out as early as possible. The use of reproductive incapacitation such as induction of triploidy in fish, may be used and if so must be covered in the risk assessment.
- A written record should be maintained of the experimental use and disposal of each animal or group of animals. The permanent marking of GM animals may be appropriate (depending on size), or alternatively the cages should be clearly labeled. For work with vertebrates, records required to be kept as part of a Home Office license should provide sufficient detail.
- Animals should be transported to and from the facility in appropriate animal containers.
- Access to the containment facility should be restricted.
- A set of local rules should be produced, and these should be read by all staff using the facility.
- Staff should be given appropriate training and instruction on the procedures to be carried out.

GM Animal Containment B

Containment B is recommended for GM animals which have any of the following characteristics:

- the animals could cause harm to humans or the environment if they escaped from the containment facility, **and** they have the ability to transfer novel genetic materials to local animal species,

  or

- the animals could establish outside of the containment facility,

  or

- the genetic modification increases the level of risk to human health or the environment above that of the non-modified parental organisms;

  and

- the animals have not been inoculated with GMMs or other pathogens.

In all cases Containment B must be used when Containment A is insufficient to reduce all risks to low or effectively zero.

The following procedures and containment are recommended standards of good practice and should be applied in addition to the provisions of Animal Containment A. They will need to be supplemented by measures for specific animal types (Annex I).

In many cases the measures will be a more rigorous implementation of the requirements for Containment A, such as additional barriers, or more tightly controlled access. In addition to the measures required for Containment A, the following procedures should be applied:

- Where small animals are being kept, floor drains should be avoided if possible. For older animal houses this may not be practicable, and double mesh barriers on drains should be used. These should be checked on a regular basis.
- Written operating procedures should be produced for all routine operations carried out within the facility.
- Staff should be given appropriate training and instructions on the procedures to be carried out, and written records of training should be kept.
- Written records of any accidents or escapes from cages or primary containment should be kept.
- The containment area must be kept locked, and access tightly restricted. Security measures must be implemented to prevent theft or intentional release of animals through vandalism. Regular security patrols, and/or the use of closed circuit television may be appropriate.
- Discharge of water from tanks holding aquatic animals must not be direct to drain, but should pass through several filters. Regular checks should be made to ensure that filters

are kept clean. If discharge into rivers or the marine environment is considered, additional protective measures should be implemented.

General features to be monitored for their GM compliance of the building

The facility should be lockable and isolated generally from other area of human and animal inhabitation.

There should be separate rooms for each of the following: staff offices, staff tea room, staff showers and toilets, animal housing, manipulative procedures (injection, bleeding, surgery, testing, and euthanasia), food storage rooms and quarantine. Separate areas should also be provided for cage cleaning/washing and garbage handling/storage. There should be separate delivery access and lifts to avoid mixing human and animal traffic. All restricted areas should be clearly signposted. Doors should have vision panels.

All surfaces should be impervious, including wall/ floor/ceiling surfaces. Rodents and wild birds should not have access. False ceilings are not recommended as they create a haven for cockroaches. Walls should be smooth or rendered to facilitate cleaning. Hand basins should be provided in a convenient location. Drainage should be adequate and in accordance with treatment for the effluents, waste materials and fecal discharge.

A 'contamination barrier' should be provided at the entrance/exit to the animal house. This area should include shower and laundry (footbaths are not considered sufficiently effective) and clothing storage space.

The pressure gradient at which animal rooms are ventilated has implications for human and animal health. Where possible, non-animal areas (e.g. corridors) should not receive contaminated air from animal areas. A negative pressure gradient inside animal rooms will minimise this but may compromise animal health. On the other hand, specific pathogen free rooms and operating theatres should have positive pressure to avoid contaminants entering these rooms. Users of animal houses should be consulted to determine the pressure gradients required for each area. Where practicable, exhaust ducts should be close to floor level where the concentration of animal residue is highest. The exhaust air should be pre-filtered, then subjected to HEPA (high efficiency particle arresting) filtration, before being discharged. Rooms which do not have HEPA filtration should not be used for potentially infected animals until filtration has been upgraded. Exhaust ducts for effluent air should have removable grills so that they can be maintained free of fur and other particulates. Exhaust ducts should not be placed in populated or enclosed areas, such as a frequently used footpath or courtyard (IT IS THE DUTY OF THE MONITORING AGENCY TO BE AWARE OF THESE INDICATORS AND DOCUMENT THEM AT EVERY INSPECTION OF THE FACILITY).

Local exhaust ventilation must be provided in operating theatres to exhaust anaesthetic gases at the source of generation. Local exhaust ventilation should also be provided in areas

where there is a high production of dusts, aerosols, etc. (e.g. emptying feed bags, cleaning cages, handling sawdust). Where this is not practicable a charcoal filter mask or airstream helmet should be used. In some cases, e.g. handling sawdust, both exhaust ventilation and respiratory equipment may be required. Work with animals involving volatile anaesthetics, particularly in an open system, should be done in a fume cupboard, or using local exhaust ventilation. Where practicable, vapouriser-style anaesthetic apparatus should be used or anaesthetic machines should be fitted with scavenging units. Beakers of soaked cotton wool are not appropriate. A reduction in stock density also reduces levels of airborne allergens and exposure to animal byproducts

Annex 1 - Additional Recommendations For Containment Of Specific GM Animal Types

a. Small mammals (rodents e.g. mice etc)

- Animals should be kept in appropriate cages. Cage sizes and minimum space requirements should be in accordance with Animal Ethics Committee. Cleaning procedures should be instituted which minimize the likelihood of escape.
- Floor drains and low level ventilation should be avoided, or made escape proof through the use of wire mesh or similar barriers.
- Appropriate rodent traps should be used.
- All animals should be tagged or marked, to allow individuals to be identified. Cages should be clearly marked.
- Experimental procedures, such as the administration of drugs and the bleeding of animals should be carried out in a way that minimizes chance of escape.

b. Large mammals

- Animals should be kept in appropriate pens or fenced areas. Double fencing may be appropriate, dependent on the level of risk.
- Where the fenced area is in a remote location, or some distance from the main buildings, security measures should be taken to prevent theft or vandalism. Regular monitoring of the perimeter fencing, and/or the use of closed circuit television may be appropriate.
- In the case of animals that might burrow, the fencing should go down to a sufficient depth to minimize or prevent escape.
- Fencing should be of sufficient height and mesh size to prevent egress.
- Written records should be kept for all animals, including births, deaths and movement to the incinerator.

c. Aquatic animals

- Fish, including developing fertilized eggs should be kept in appropriate tanks. Tanks should have filters of sufficient mesh size to retain the smallest organism likely to be

present. At the early stage of embryo development, the mesh size should be determined through knowledge of the variation in egg size.

- Secondary filters should be used to retain any eggs that may be detached from the hatching trays and also to prevent escape of fish throughout the life cycle; the number of secondary filters required will depend on the risk assessment.
- A cleaning regime should be instituted to prevent filter clogging. Filters should be checked regularly, particularly if water supply is from a river, or the sea, to prevent build up of algae or other material. Consideration should be given to the (sand) filtration of supply if build up of algae is identified as a major problem.
- High water alarms may be required depending on the risk assessment. It is likely that low water alarms may be used to protect stocks.
- A Secondary containment may be required in case of overflow or rupture of vessels or tanks. Rupture or other damage may occur where people have to enter the tank to clean filters. Such procedures should be avoided where possible - for example, the use of long handled brushes may provide an alternative.
- The containment area may need to be bunded to prevent overflow to outside. This would depend on the risk assessment and geographical considerations, such as proximity to watercourses or sea. (In several countries, GM fish cannot be handled in any other water bodies than those which are completely land locked within a limit of less than 10 X 10 m with sub tanks for each event separation)
- Consideration should be given to the use of high water alarms at floor level, so that flooding is detected early. The alarm system should be audible and visible throughout the site and operate 24 hours a day.
- The use of a "soak away" outside the facility should be considered if the facility is close to a river or the sea. Such an area may consist of a graveled area which allows water to soak through whilst retaining any escaped fish on the surface.
- Where an outlet pipe from a contained facility discharges directly into a river or the sea, extra care will need to be taken. Consideration should be given to the use of a filter barrier on the pipe into the final holding tank. An electrical kill system typical of the kind used in the aquaculture industry may provide a suitable final barrier before final discharge.

c. Invertebrates

- Appropriate cages or culture vessels should be used.
- The use of secondary containment measures, such as muslin "tents" should be considered if indicated by the risk assessment.
- Measures should be taken to enable escaped invertebrates to be detected and recaptured or destroyed. For ticks and mites, containers should be kept over trays of oil.

- All experimental cages/pens must be numbered and documented.
- Used culture vessels must be decontaminated before disposal or thoroughly cleaned before re-use.
- Flying or crawling arthropods should be handled on white trays to facilitate the detection of escape.
- The use of an electric insect control unit should be considered. - The activity of the arthropod and the risk of accidental escape can be reduced by chilling, or keeping cages in cold rooms. The use of chilled corridors surrounding an insectory also helps prevent egress.

Important

Till a larger body of information is made available, the GM animals should not be used for other hazardous of infectious disease related vaccine production activities. The monitoring of this activity has to be locally devised by physically marking, segregating and labeling individual animals so that there is no risk of a GM based protein product or serum gets into a disease or industry or food processing industry.

- In the event of a GM animal developing an accidental infection, its treatment should be done under isolation within the containment
- In the event of death of a GM animal due to unnatural causes, the autopsy has to be carried out in a BL3 level containment as done in the case of diseased animals which are examined through autopsy.

This means that at least ONE BL3 level animal room is required when dealing with large animals irrespective of the containment level of the GM animal of A or B.

*[**Source**: abstracted from the ACGM Compendium of Guidance, March 2000 issue AND Guidelines to Animal Containment Facilities (revised),OH & S Unit, University of Queensland, Australia. 2003*]

Monitoring Field Trials of GM Plants

Issues in transgenic plant experiments and methods for proceeding step by step (Ghosh, 2002)

The issues that are taken into consideration before authorizing field trials under contained conditions using GM plants include the potential of the transgenic plants for dissemination into the open environment such as through cross pollination, the dispersal mechanism of the pollens as well as the seeds, the presence of wild members of the species in the eco-system and the presence of other non-transgenic planting materials in the vicinity. While designing field experiments efforts are made to maintain appropriate reproductive isolation so as to prevent the likely-hood of seed setting outside the experimental plot. The transgenic plants are isolated from the gene pool represented by sexually compatible plants to prevent the escape of transgenes. Conditions are also introduced in certain cases to prevent flowering of plants.

It is ensured that the genes or the genetically modified plants are not released into the environment beyond the experimental sites. Only such plants are taken into the open environment for experimentation, which have the minimum chance of unintended and uncontrolled adverse affects. The time of sowing, flowering and planting are also taken note of. Only those plants have been used in Indian trials for open field experiments under contained conditions, where the transgenes are considered to be safe or where the pollens are linked with imparting male sterility properties. Experiments have also been designed to study the potential for gene transfer and the consequence of transferring transgenic properties to weeds or other near relatives. The probability of pollen transfer and the natural mutation rate have been made conditions for computation in the experimental designs. The transgenic traits that have been looked at in such experiments in India include Bt-insect resistance, Bar resistance, Bar-barnace as well as Bar-barstar systems, Bar-Bt systems, antibiotic resistance, altered nutritional properties and abiotic stress resistance properties. As indicated earlier, data for submission by the applicants include mating systems in plants comparison of germination rate, invasiveness, toxicity and allergenicity or alterations in the anti-nutritional properties of the plants due to the transgenes including the marker genes etc.

The monitoring of the field trial where there should be no cause for any gene spread to higher organisms, the soil and airborne pests or organisms might be influenced. This factor should be kept in mind while recording data from a field trial release while monitoring.

The Indian model : Considering its topography and agroecological climate, the Indian model for field testing may be appropriate with modifications that suit case by case requirement of the concerned transgenic. In India, a detailed format for submitting information has been devised comprising nine chapters, and applicants are required to provide such information to the Government of India seeking permission for commercial release of target transgenic plants under Rules 7,8,9,10 or 11 of the above Notification (Enclosed separately). A few experimental designs have been evolved and approved by the RCGM for conducting trials using GM plants in the open environment.

The designs are for monitoring and studying pollen dispersal, the comparison of cross-ability of non-transgenic plants with the transgenic is and evaluation of their comparative competitiveness or invasiveness potential in unmanaged and managed land. The experimental result from two studies has shown that the pollen escape was real phenomenon. The cross-ability studies conducted for example on transgenic Indian mustard has shown that their existed pre and post fertilization barriers and the results corroborated the classical literature, confirming that escape of transgenes from same crops like the Indian mustard crop was not favoured in nature; however, viable F1 seeds could be produced by manual cross-pollination with related cultivated as well as wild species, which observation was consistent with similar studies made with Brassica napus. It was observed, while studying the Bt. Cotton plants that their pollen also traveled to some distance with the help of insects. It can be stated from these that gene transfer shall be taking place in open environment when transgenic plants are

cultivated. By appropriate management practices it might be possible to reduce the extent of pollen transfer into the open environment for all crops, but it cannot be fully contained. Therefore, the consequence of gene transfer is an issue, which is real. The implications of this issue have not yet been satisfactory resolved. A decision has to be taken by the Indian Government on this to decide to what extent transgene flow can be allowed and what are the consequential risks, taking also into consideration the agronomic benefits expected from the use of transgenic plants. In March, 2002, the Indian Government finalized its decision on the commercialization of insect resistant Bt. Cotton containing Cry 1 Ac gene. Three cotton hybrids containing the gene were approved for commercial cultivation in India, subject to certain conditions. The conditions were worked out based on the experimental results of Bt cotton, conducted in India. These have been discussed in detail later on. In addition to these experiments, major chunks of data are required to be generated on food safety in accordance with the latest Indian guidelines. The information emphasizes quantitative production of transgenic proteins and their effects on as-is-where-is basis on experimental animals in the context of determining the toxicity allergenicity and anitnutritional properties etc., The data generated in Indian experiments for Bt cotton at Industrial Toxicology Research Centre, Lucknow using goat as the ruminant modes, and for transgenic Indian mustard assessed on rat, rabbit, guinea pig and hen model (at Shriram Industrial Research, Delhi) as well as on goats model (at Fredrick Institute of Plant Protection and Toxicology, Tamilnadu) did not show any additional food safety risks.

The transgenic field experiments conducted in India has enabled the country to have hands on experience on several genetically modified plants. Most important among them are transgenic Bt cotton, Bar-Barnace and Bar-Barstar mustard and Bt tomato. Data generated in India has demonstrated substantial agronomic benefits from transgenic plants over the corresponding non-transgenic controls.

Monitoring and evaluation mechanisms for green house / net house experiments and limited field trials in the open environment in India

The RCGM can bring out manuals of Guidelines specifying procedures for regulatory process with respect to activities involving genetically engineered organisms in research and applications to ensure environmental safety. To monitor, over a period of time, the impact of transgenic plants on the environment, a special Monitoring cum Evaluation Committee of the following constitution will be set up by the RCGM. The Committee shall have the following constitution.

a) Chairman of the Committee : Secretary, DBT & Secretary, DARE shall jointly discuss and elect a leader of the Committee.
b) Eminent Plant Biotechnologists 3-4 scientists nominated by ICAR
c) Seed Technologists 2-3 scientists nominated by ICAR

d) Plant Breeders 2-3 scientists nominated by ICAR

e) Plant Ecologist/Environmentalist 2-3 scientists nominated by GEAC

f) Nominee of NBPGR

g) Nominee of MoE&F

h) Member-Secretary nominated by RCGM

This committee will undertake field visits at the experimental site/s. The committee shall be guided by the RCGM on the design of field experiments and on the preparation of formats for collecting scientific information on plants in green house / net hoi.3se conditions as well as in limited field trials. Based on the on-the-spot situation the committee can suggest remedial measures to adjust the original trial design and assist the RCGM in collecting, consolidating and analyzing the field data for evaluating the environmental risks emanating from the transgenic plants. This committee shall also collect or cause to collect the information on the comparative agronomic advantages of the transgenic plants. From time to time, the committee shall advise the RCGM on the risks and benefits from the use of the transgenic plants put into evaluation. Trials will be done for at least one year with minimum four replications and ten locations in the agroecological zone for which the material is intended. The biological advantage of transgenics will have to be clearly enumerated by the applicant, the Institution, the University or the Industry. The latter would recommend those transgenics, which would be found to be environmentally safe and economically viable by the RCGM, to the Genetic Engineering Approval Committee for consideration for release into the environment

Biosafety aspects of the transgenic plants

Field experiments are designed to systematically identify the hazards, to access to risks and to take step to manage the risks by applying logically valid strategies, to systematically identify the hazards and to assess the risks; the information on the following aspects would be required to be generated.

I. Characteristics of the donor organisms providing the target nucleic acids. These may include the following which can be observed during the field trial

a. Name of the donor organisms 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 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, especially with lower organisms, insect pests, and microbes such as beneficial microbes should be assessed. Organized samples of microbe sampling can be done and analyzed for the presence of

the gene through one of the tests mentioned in the Chapter on monitoring microorganisms

f. Any odd behavior shown the GM towards known responses to both biotic factors and abiotic factors.

II. 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 (relevant with reference to the details on I (d) above).

III. Characteristics of the transgenic inserts : These may include the following,

a. the specific functions coded by the inserted nucleic 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.

IV. 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 despite the isolation provided for which random seed samples from single plant, single seed to be collected and progeny analyzed through molecular tests.
e. Pathogenicity, toxicity and allergenicity of the transgenic plants and their fruits to human and animals.

Information on many of the above questions may already be available. Many questions may however be required to be investigated and answers found out, for which appropriate new experiments would have to be designed to gather data. For generating toxicity and allergenicity data, standard protocols devised by international agencies could be used. The Indian national toxicological laboratory like the Industrial Toxicology Research Centre, Lucknow could be consulted to generate appropriate protocol for these purposes.

For minimizing the risk arising from the limited release of transgenic plants, the following may be taken into consideration :

a. Special separation for isolation, for preventing reproduction/fertilization and seed setting.
b. Biological prevention of flowing 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.

Thorough comparison with national checks for productivity and susceptibility/resistance to biotic and abiotic stresses will have to be made.

Experimental designs used in the field trial and their analysis

The experiment has to be properly designed in the field to evaluate the potential addition to the value of the variety over its non-transformed type. The data should be analyzed in replicated design with statistical analysis and quantified expression of the trait. Any deviation from the approved design should not be considered unless approved by the MEC/RCGM.

All the information as above are to be available in the form of a document which would be called the registration document. An outline of the ingredients of a registration document is available at the web site : http;//www.dbtindia.nic.in

Post-harvest treatment of the site

It is important for the monitoring agency to be satisfied with the post harvest treatment of the left over debris after the economic product harvest of the field trial. What was the type of the waste and how was it treated to eliminate any spread of the volunteers is to be ensured.

Summary of monitoring indicators in a limited field trial , an example

1. *Conduct of the trial :* Is the trial conducted as per the approved field design with the replications and plot size mentioned ?

2. *Isolation:* Is the isolation distance of 50 mts (as in a oilseed mustard crop) around the experimental area maintained with no related species or varieties of the same species in the area?
3. *Toxicity/allergenicity data :* Is the impact of the transgene product for its likelihood of causing any allergies or toxicity symptoms in lab animals as well as any adverse effects on their immune system analyzed ? (If no, the second year trial cannot be conducted on multiple locations). For this purpose, the guidelines are explicit with reference to the kinds of allergies to be tested depending on the kind of gene product (whether part of food chain or otherwise) and toxicity data with reference to consumption of the product (DBT guidelines, 2003 modified, http//:www.dbtindia.nic.in)
4. Are three photographs clearly documenting the isolation of the crop right through planting to harvesting and post harvest management of crop debris appended with the results? If no, again the experiment cannot be taken for another year under multiplication during which period, till the next season, an evaluation of the possibility of volunteers left behind is to be done in the original land.
5. Safe storage of harvested seed and salvaging any spill in the field : Is sufficient care taken to harvest as much of seed as possible and no seed is spilled and left behind/ What measures were taken?
6. *Maintenance of field data :* Entire experimental data are to be maintained and recorded with the monitoring agency.
7. Are all the safety guidelines with respect to the personnel working with the experimenters taken care of?
8. Were any accidents encountered? How was the IBSC and accident emergency attended to by the concerned authorities designated for the purpose by the Institute ? Appropriate proof must be attached in the event of an accident.
9. Were the concerned state government authorities informed of the trial?
10. *Maintenance of the logbook:* The experiment conducted in a fenced area maintained under lock was to be allowed for entry only to the listed persons mentioned in the permit letter or their representatives sufficiently well informed. Was each entry visibly maintained each day when ever there was a field activity?
11. Was any unknown pest, insect or pathogen harmful or otherwise noted on the transgenic crop ? If so, was it brought to the notice of IBSC? What was the action taken about the observation?

Monitoring Commercial Release GM Plants

There is a striking difference between the field trial referred above under confinement or limited conditions and the commercial release of the GM crop in the basic purposes behind the release. The first one is to primarily assess if the material can be actually released into

environment safely and beneficially for the utility of the embedded transgene in the variety. The latter one is purely for commercial viability of the material. While the former one is collectively not going to cover an area like 10 acres at the maximum under isolation, the latter will potentially grown freely in 100s of acres. The former is with an isolation from its own kind of species as well as other related weed species., the latter one is completely free to be grown beside the same crop grown to a normal variety in the open. Therefore, the concerns are different, the impact is different as much as the likely long term effects on the ecology and environment in which a large area is grown. Some concerns which have to be definitely viewed with reference to the gene, crop, geographic region and area of cultivation in a holistic manner specific to the situation than with a general view point. However, there are certain common concerns which occur in varying degrees that need to be addressed while considering a commercial release of the GM.

a. *Gene dispersal and persistence* *:* The ecological spread of the transgene is accomplished by horizontal transfer, dispersal of whole organisms and into new environments and organisms. The persistence of the transgenes depends largely on how these affect the organism's evolutionary fitness. Gene dispersal can occur actively from pollen,. seeds and propagules. Passive dispersal can occur through trade transit, spillage during and after harvest while in transport. Hundreds of invasive species have successfully colonized new regions after unintentional or deliberate dispersal over thousands of miles (Mack and Eisenberg, 2002). Gamete dispersal provides an opportunity for sexual transfer of the transgenes to wild or domesticated relatives as has been observed in the past (BANR and BLS, 2004).

Generally, if an allele confers a fitness advantage to the individual possessing it, it is expected to increase in frequency while, if it is detrimental or competitively less superior to the alternate wild type allele, it is bound to get extinct over a period of time, provided there is no recurrent immigration of the new allele. Experimental field studies have shown drastically different fitness impacts due to different pest resistance transgenes (Burke and Rieseberg, 2003 and Snow et al 2003.

b. *Weediness or invasiveness* *:* This is the most publicized concern in transgene spread phenomenon. The weediness or invasiveness is expected to be a result of sexual transfer of crop alleles to wild relatives. This is not exclusive to transgenes alone, though. Sometimes, the transgenic plant itself may become an environmental problem if the traits expressed altered its performance such that it becomes an invasive or nuisance species. The factors that limit invasiveness of populations are still to be understood clearly for theorization and conclusive evidence.

c. *Extinction of wild taxa* *.:* Due to overwhelming growth of one crop, other related taxa are rendered near extinct which again is not a new phenomenon to traditionally developed new plant types which when introduced tend to eliminate the local land races.

d. *Gene flow to other domesticated organisms* *:* There could be gene flow among transgenics for different genes causing a transgenic stacking that turns a transgenic into double or triple gene line for transgenes (Hall et al. 2000).

e. ***Effect on non-target species****:* Another major concern voiced by ecologists and evolutionists where there are varied interpretations of Bt corn causing lethality to monarch butterfly (Losey et al. 1999 and Sears et al. 2001).

f. ***Delaying the evolution of resistance:*** Although the evolution of resistance is a continuous process, the evolution of resistant pest to the transgene is considered potentially a greater hazard to environment over the normal evolution in nature because more environmentally damaging alternative treatments would be needed for continued control of the broken down resistance.

g. ***Detection of the transgenes from other samples:*** The use of molecular tools such as PCR or ELISA to detect either the gene or protein in all the potential recipients is a quick strategy with appropriate population genetical inputs to generalize the spread.

The measures to reduce in-field contamination have to be clearly emphasized by the seed marketers to the farmers because more often than not, the contamination is from seed impurity of the GM seed that contaminates a normal seed where harvest handling and post harvest handling is done in large-scale by unattended machines. Some of the techniques that minimize the spread through contamination are,

a. efficient weed control by herbicides

b. decreasing the importance of farm-saved seed

c. managing populations in field borders

d. Fallow

e. Isolation in seed production plots

f. lengthening the rotation by introducing a spring crop in which the volunteers cannot flower

g. Staggering the sowing of GM and non-GM by sharing the information among neighbor farm units

In the case of biotic stress resistances such as insect or bacterial resistance, there is a necessity to use refugia, which is recommended to be 20% of the total GM in a given area. This is to be monitored if the commercial farm producer has followed it and the seed marketer has stipulated the same.

The specific factors to consider when assessing /monitoring potential hazards posed by GM plants released in an environment commercially :

1. Purpose of the release
2. Site of the release, if it was different from the natural habitat of the crop
3. Geographical location : a. Release area proposed, b. Actual area where released
4. Proximity of the release area to recognized protected areas such as water reservoirs, bioparks, and sanctuaries. Any reported variation within an year of the release.

5. Adverse effects on plants:
   - direct toxicity to other plants (e.g. root exudates)
   - increased weediness characteristics in the agricultural environment (e.g. increased number of small potato tubers - problems with volunteers in subsequent years)
   - increased invasiveness of natural habitats is exhibiting selective advantage under specific selection pressures (e.g. invasion of salt marsh SSSI due to increased salt tolerance)
   - altered susceptibility to pests and disease, thereby providing new reservoirs for pests and diseases with potentially altered dissemination routes (e.g. by inactivation of endogenous resistance genes)
   - creation of novel pathogens in the modified plant (e.g. virus recombination/t ranscapsidation etc)
6. Adverse effects on animals (e.g. herbivores, pests and predators of pests):
   - direct toxicity to herbivores/plant pests
   - indirect toxicity effects on predators of herbivores/plant pests (i.e. non-target effects)
   - increased allergenicity/toxicity of plant pollen/plant sap
7. Adverse effects on humans (both those working with, coming into contact with and in the vicinity of the receiving environment):
   - increased allergenicity/toxicity of plant sap (assuming people will not be eating plants)
   - increased allergenicity/toxicity of plant pollen
8. Other adverse effects on the environment
   - effect on biogeochemical cycling from decaying GM plant material (e.g. Nitrogen cycling)
   - effect on soil flora and fauna from decaying GM plant material
   - effect on soil micro-organisms from expression of inserted genes
   - altered management practices/compromised plant protection strategies
   - negative economic effects of transgene contamination of organic crops/non-GM crops for sale to non-GM markets
9. Potential for transfer of genetic material between the GMO and other organisms

Once the hazard assessments have been made for the GM plant being modified, assess more indirect/delayed hazards caused by the capacity of GM plant to transfer transgenes to other organisms in the receiving environment e.g. by pollen transfer to sexually compatible crop species/sexually compatible wild relatives or by horizontal gene transfer to other organisms via micro-organisms in the soil rhizosphere. If such gene transfer is likely to occur, revisit the hazards specified above for the recipients of the transgene.

Table: Some examples of wild species and crops where introgressive hybridization may be important for gene transfer of herbicide resistance

Crop	Weed species
barley (*Hordeum vulgare* L.)	wild barleys (*Hordeum* spp.)
canola (*Brassica napus* L.)	numerous wild mustards
carrot (*Daucus carota* L.)	wild carrot (*Daucus carota* L.)
corn (*Zea mays* L.)	teosinte (*Zea mays* spp. *mexicana*)
foxtail millet (*Setaria italica* L.)	green foxtail (*Setaria viridis* L.)
poplar (*Populus* spp.)	cottonwood (*Populus* spp.)
lettuce (*Lactuca sativa* L.)	prickly lettuce (*Lactuca serriola* L.)
oat (*Avena sativa* L.)	wild oat (*Avena fatua* L.)
radish (*Raphanus sativus* L.)	wild radish (*Raphanus sativus* L.)
rice (*Oryza sativa* L.)	red rice (*Oryza sativa* L.)
sorghum (*Sorghum bicolor* (L.)	johnsongrass (*Sorghum hulepense* (L.) Pers)
squash/pumpkin (*Curcbita* spp.)	wild cucurbit species (*Cucubita* spp.)
sugarbeet (*Beta vulgaris*. vulgaris)	wild beet (*Beta vulgaris* spp. *maritima*)
sunflower (*Helianthus annuus* L.)	wild sunflower species (*Helianthussp.)*
wheat (*Trielcum aestivum* L.)	jointed goatgrass (*Aegilops cylindrica* Host)

Beyond the opportunity for gene flow, the consequence of that gene flow must be evaluated. Hybrids are known to occur between the crop and the weed species; however, not all hybrids are fertile. Some hybrids are fertile and display hybrid

10. Protocols of field trials performed in the previous years with the genetically modified and control crops must be specified and documented with respect to:

Agronomic traits

Compositional analysis represents a key component of the risk assessment process. However, unintended effects may also manifest themselves through, for example, changes in susceptibility to important pests and diseases, through morphological and developmental changes or through modified responses to agronomic and crop management regimes.

Environmental risk assessment

Environmental risk assessments are carried out on a case-by-case basis taking into account the biology of the recipient plant, the characteristics of the introduced genetic material, the properties and consequences of the genetic modification, the scale of release and

the evaluation of any risk to the receiving environment that might arise from the release of the GMO. Variable expression or even gene silencing can cause a serious threat to the economic value of the GM product. If a herbicide tolerant gene does not express due to a silencing event, spray of the herbicide would kill the transgenic plant too and cause mass destruction of the crop in the field. While this may not cause a direct environmental risk, but it may lead to a secondary level due to proliferation of saprophytes.

Examples of possible interactions between the GM plant and its environment including potential impact on other organisms are:

– effects on the dynamics of populations of species in the receiving environment and the genetic diversity of each of these populations;
– altered susceptibility to pathogens facilitating the dissemination of infectious diseases and/or creating new reservoirs or vectors;
– compromising prophylactic or therapeutic medical, veterinary, or plant protection treatments, for example by transfer of genes conferring resistance to antibiotics used in human or veterinary medicine;
– effects on biogeochemistry (biogeochemical cycles), particularly carbon and nitrogen recycling through changes in soil decomposition of organic material.

11. ***Geographical relevance of data***

Data should be provided from field experiments in areas representative of those geographical regions where the GM plant will be grown commercially in order to reflect relevant meteorological, soil and agronomic conditions. Where data from field studies on other continents are supplied, the notifier should submit a reasoned argument that the data is applicable to specific conditions.

12. ***Impact on wild plants***

The potential consequence arising from out-crossing to compatible wild species should be considered and assessed for environmental risk. This will depend on sexually compatible plants being present and available outside the crop to receive pollen and produce fertile hybrids. Selection pressure in non-crop habitats that is required to maintain the selective advantage of any transferred trait should be identified. For example, transferred herbicide tolerance may not be an advantageous trait in habitats where the herbicide is not applied.

13. ***Impact on non-modified crops***

The potential consequence arising from out-crossing to other crop cultivars should be considered and assessed for environmental risk. This will vary with crop. For example, the release of GM oilseed rape raises the issue of gene transfer, since this crop will readily cross pollinate with nearby oilseed rape crops and may spontaneously hybridize with some wild

relatives. In cases where gene transfer cannot be prevented between certain adjacent crops of, for example, oilseed rape or maize, the risk assessment should focus on the consequences of cross pollination even at very low frequency.

14. ***Impact on organisms and ecological processes***

Risk assessments should be carried out for each of the different functional environmental compartments that are exposed to the GM plant. Whether any parts of it will remain in the environment after harvest, will depend on the specific crop and its management regime or agronomic practices. Soil fertility strongly influences the growth and productivity of plants. As rhizosphere and soil microbial communities perform the vital biotransformation that underpins soil fertility any negative impact(s) on microbial participants in this key compartment would have to be carefully evaluated. This should be assessed on a case-by-case basis with particular reference to the nature of the introduced trait and the consequences of the genetic modification/alteration in the GM plant. The risk assessment should aim to establish if direct or indirect effect(s) of the genetic modification in the GM plant have any long-term or sustainable deleterious effect on the recognized soil microbial communities and the associated functional activities that are responsible for maintaining the agronomically relevant processes of soil fertility and plant productivity. The assessment should also address the fate of any (newly) expressed substance(s) in those environmental compartments where they are introduced and which result in exposure of non-target organisms (e.g. in soil after the incorporation of plant material). Risk assessment should also include an analysis to determine if a shift occurs in populations of deleterious organisms in the presence of the modified plant. Exposure should also be estimated to soil organisms and decomposition function (e.g. earthworms, micro-organisms, leaf litter breakdown) in relation to potential transfer to soil micro-fauna and impact on degradation.

Impact should be assessed on non-target arthropods (including pollinators, beneficial and predatory arthropods), grazing birds and mammals or, if appropriate, the aquatic environment. Such studies should include laboratory, greenhouse or field exposure experiments set up in such a way that enough statistical power is obtained to be able to observe possible negative impacts on non-target organisms. This risk assessment should take account of where in the plant and to what degree the inserted genes are expressed and therefore the extent to which non-target organisms are exposed either directly or indirectly.

Data on the comparative susceptibility of the GM plant to pests and diseases compared with that of the non-modified plants are useful indicators of effects together with observations on agronomic performance during greenhouse and experimental field trials.

An assessment of the potential impact of growing GM crops on wider biodiversity in the crop ecosystem requires the combination of several different approaches. The notifier should describe the appropriate commercial management regime for the crop including changes in pesticide applications, rotations and other crop protection measures where different from the

equivalent non-GM crop under representative conditions. The notifier should aim to assess the direct and indirect, immediate and delayed effects, of the management of the GM crop on all affected habitats. This should include the biodiversity within the GM crop and adjacent non-crop habitats. The necessary scale of such studies will depend on the level of risk associated with a gene in question and the impact.

15. ***Methods for monitoring the GMOs***

a. Detection of the GMO as contaminants
b. Gene movement through pollen spread
c. Ecosystem effects (other non-target organisms, plants, insects, pests)
d. Any non-targeted pest incidence assessment
e. Any report of a allergy response or toxicity effect that does not match with the previous year's data. Ideally, a second year data also should be generated from the fresh end product of the GMO on human health aspects of allergenicity and toxicity induced by large scale exposure to human beings and animals

Monitoring GMO Imports

World wide, plant quarantine is a legal enforcement measure aimed to prevent pests and pathogens from spreading or to prevent these from multiplying further, in case these have already found entry and have established in the new restricted area. The same is extended to the imported GMOs with insured biosafety measures followed while undertaking the quarantine processing of imported seeds/planting materials of germplasm of GMOs meant for release in the entered country from a foreign source. There is a need for controlled testing of transgenic planting material, in containment greenhouse prior to release to the environment so as to avoid their potential risk to environment or health. Therefore, monitoring the import, the quarantine procedure and post quarantine handling/movement of the GMOs is very crucial to regulate proper application of the GMOs and prevent any form of unintended biosafety regulation violations or oversight.

The typical steps involved in monitoring the import of GMOs

a. ***Adequate information on the nature of the transgene, its expression level in the host environment***

The importing Institution/Organization should be fully aware of the nature of the transgene, its source of origin(bacterial, animal/insect, plant), hazard/risk involved and the product of the transgene in the specific host plant material the gene is integrated.

b. ***Clearance from GM regulatory authority in the GM receiving country***

The statutory GM regulatory authority is required to clear the import proposal of the material after assessing,

- the purpose behind the import,
- the product of the transgene with reference to the targeted ecological area,
- detection methodology already employed for detecting the presence of the transgene in the host material,
- known information on regarding the toxicity/allergenicity of the transgene product
- extent of the transgene expression,
- biochemical/physiological consequence or output of the transgene product in a host material,
- the targeted host if the material is in the form of gene-construct vis-à-vis the presence of the product of the proposed transgene,
- research/commercial permit that the material is granted in the host country,
- any IPR regulations connected with the transgene or material for implied restriction of application in the importing country and
- potential utility of the transgene characteristics vis a vis target crop/crops or microbe

c. ***Award of import permit and authorized import accompanied by a phytosanitary certification***

For convenient monitoring, it is necessary that a single nodal agency (with multiple terminals in the case of geographically distributed or large countries) is authorized to award an import license by specifically documenting the existence of an already earlier import of the material with its accession number so that the quarantine unit of the importing country is simultaneously made aware of such a pending import. If there are multiple agencies authorized to award import license, documentation of the incoming material, its reference accession identity can become redundant making monitoring a difficult as well as expensive exercise. While the material is actually being imported, it is required to be accompanied with the original import permit and phytosanitary certificate on the material from the country of export.

d. ***Documentation of the national accession number after entry into the importing country***

A proper databank of all imports has to be maintained with complete information documentation in respect of the material being imported. This is necessary before the material is processed in quarantine set up for monitoring and perceived risk assessment if similar material has a history of import and quarantine processing. The perceived risks can be directly with reference to the foreign transgene or with reference to the crop (if seed or planting

material is imported) or both. The range of risk can be from suspected pests, pathogens, allergens, contamination of adventitious materials, and transgene product in the specific material if already imported earlier, etc.

Assigning specific accession number to every entry which has to be done carefully, by eliminating any duplication, if already imported earlier. An accession number to the material, then becomes the reference number of the specific material for every utilization of the material in deployment, enhancement or commercial utilization subsequently in the country of import.

e. ***Quarantine processing***

Once the material is identified with an accession number by the importing country, GM material is passed through proper quarantine filters taking into consideration the recommendation of the GM regulatory authority on the material while granting the clearance of the import proposal.

After passing through the routine quarantine processes suitable to every planting material, the material has to be necessarily grown in a containment if it is not a bacterial culture with a transgene plasmid vector for one season.

Sampling from bulk imports (ISTA standards)

The sampling procedure is designed to collect a sample that is representative of the consignment as a whole. Several facts are assumed including:

- Individual seeds are either GM or not GM
- Any GM seeds present are randomly dispersed throughout the consignment.
- The sample will be ground and analyzed as a whole, seeds will not be analyzed individually.
- The laboratory will correctly identify the presence or absence of GM material in 99% of samples.

It is required to keep a high level of confidence (95%) that the inadvertent presence of 1 GM seed in 1000 seeds will be detected. In order to achieve this a sample (weight basis) drawn from a consignment for testing must contain at least 3200 seeds (The no. of grains required to detect 0.1% contamination with 95% probability). The weight of the sample size can be calculated by multiplying the standard 100 seed weight by 32 and rounding up to the nearest 5 grams.

Testing laboratories must have validated PCR methods capable of detecting GM seed in the seed sample.

The sample will be collected using either the standard International Seed Testing Association (ISTA) or Association of Official Seed Analysts (AOSA) methodology. The ISTA methodology is summarized in the following tables:

Consignments up to 100kg:

Number of bags or containers per consignment	1-4	5-8	9-15	16-30	31-59	more
Number of sub-samples	3 from each bag or container	2 from each bag or container	1 from each bag or container	15 total each bag or container	20 total each bag or container	30 total each bag or container

Consignments exceeding 100kg:

Weight of line	100-500 kg	501-3,000 kg	3001-20,000 kg	20,001 kg & above
Number of sub-samples	5	1 per 300kg but not less than 5	1 per 500kg but not less than 10	1 per 700kg but not less than 40

Combine the sub-samples evenly to form one uniform collection then reduce it to get a sample

In the case of research samples, where there may not be more than 50 seeds, it would be most desirable not to sample but to grow the plants and have leaf sample of equal tissue from all the plants bulked together to collect one bulk sample

During the contained growth, the GM material is subjected to

- detection of the transgene that it is documented to be carrying (as per the regulatory authority clearance),
- tested for any obvious non-target trait expression of unusual or hazardous nature including harboring seed borne pathological indications
- harvested seed tested for genetic use restriction technologies such as terminator gene and
- analyzed for disease free phytosanitary aspects before it is released to the indenter institution.

f. Storage of each accession imported

It is desirous to develop a “gene bank” with a facility to keep planting material or microbe being imported in a long term storage condition as a referral sample of the material. The sample should be both as planting material and referral DNA of the transgene as extracted from the imported material.

Post-quarantine handling and import monitoring of the GMO

The monitoring agency is required to review the import both at the site of import during its quarantine and post-quarantine handling by the indenting institution. The indicators for monitoring based on the set of information made available would be to assess,

a. The imported material permitted for its legal entry
b. The accompanying phytosanitary certification from the source country
c. Detection of the transgene in the original material imported during quarantine
d. Evaluation of the imported material for quarantine processes under containment for at least one season
e. Progeny analysis for the imported material to possess any known genetic use restricting technologies like the presence of the terminator gene
f. Marker genes the material is known to possess as a source of information for consideration during its subsequent release and commercialization
g. Handling of the material and status of the quarantine containment facility during its contained growth
h. Documentation and maintenance of the DNA from the imported material with reference to the transgene detected as the national referral sample. This referral sample would be of immense utility in the post-release monitoring of the imported material subsequently.
i. Post-quarantine storage material under medium and long term storage

An example of monitoring of imported GM materials in India:

In India, the import of GMOs is done on a single window entry of all imported GM materials through a National containment/Quarantine facility for transgenic planting material at the National Bureau of Plant Genetic Resources (NBPGR, New Delhi). The main objectives of the National Facility are: -

1. Facilitating the processing of the transgenic material from quarantine aspects.
2. Development of probes/markers as required for the containment and for evaluationof the transgenic planting material.
3. Training of the Human Resource in the area.

Presently, the existing quarantine facilities, glasshouses and molecular biology laboratories of NBPGR and National Research Centre on DNA Fingerprinting are being utilized for testing of the transgenic planting material. In addition, a medium term storage module of the NBPGR-National Gene Bank has been allocated for storing the transgenic planting material. An environmentally safe containment facility meeting the necessary Biosafety regulations of BL-3 level is in place for the purpose of testing and quarantine of transgenic planting material has been finalized in consultation with various national and overseas experts. The containment facility (app. 300 sq. mt. area) is completely sealed to

eliminate the ingress or egress of pathogens/pollens or viable plant materials. In this facility in four bays with controlled atmosphere: air temperature 20 -30 ˚C (+/- 1 ˚C) and relative humidity 50-80% (+/- 5%) for pot cultures and one of the bays with ground soil-based plants growing systems are designed. Provision has also been kept for four chambers for undertaking molecular work of the transgenic material with controlled conditions

For developing molecular probes/markers required for evaluation and molecular characterization of transgenic material, methods for DNA extraction, quantification of DNA, polymerase chain reactions (Pars) etc. have been standardized. Extracted DNA of all the transgenic lines grown in the greenhouse will be kept as referral sample and will be used for undertaking different experiments.

The monitoring processes undertaken by the Monitoring and Evaluation Committee of the RCGM involves

a. Periodic analysis of report of the Institutional Biosafety Committee on all imported GMOs (The IBSC of the NBPGR meets once in three months to monitor the activities of quarantine handling of already licensed imports cleared by the RCGM)
b. Evaluation of the documentation procedure of the import license of every GMO imported and its subsequent reporting to the regulatory authority
c. Inspection of the quarantine handling of the GMOs during quarantine
d. Inspection of the post-quarantine handling of the material (seed and molecular probe sample maintenance)
e. Inspection of the preparedness for any accidents/ physical facility failure/unintended accidental release
f. Feed-back monitoring system of the utility handling of the GMO by the indenter
g. Inactivation of spills and ensured destruction of the GMO debris as per perceived risks and adherence to the treatment protocol for all effluents and growth media materials in the containment.
i. The RCGM seeks information before granting a clearance to the indenter for import of the material with documentary evidence regarding the known risks, benefits, expression levels of the transgene material, hazard to environment and human health in the country of origin before granting the clearance. The composition of the RCGM, as explained earlier, therefore involves competent scientists in the concerned areas of interest from genetic, molecular biological, ecological and environmental aspects.

   Ref: http://www.nbpgr.nic.in for more detailed information

Information as an Essential Component of Post-Release Monitoring

The important aspect of developing a strategy or a program of a PRM in an environment is the availability of information on the GMO in question and the target environment. Although a universal mode of monitoring protocol is not possible, it is possible to develop a

document with every possible information item that is normally not historically known on the crop and on the gene as well as its product. The information should normally be able to provide answers to

a. What do we monitor ?
b. How do we monitor?
c. When do we monitor?
d. Why do we need to monitor?
e. How long and much do we monitor?

What do we monitor

The questions are basic in nature and each question is multi-dimensional in its perspective. For example, when we ask what do we monitor, what actually we seek as information that can provide answers are items such as the crop, the target organism (if the gene is pest or pathogen resistant), the gene product or expression, non-target organisms. These items of information were only related directly to the gene. This does not mean other seemingly unrelated information set dealing with the less obvious data with reference to the GMO and the environment is any less important.

Depending on the gene, habitat, cultural practices, traits like type of grain produced, the plant behaviour in competition during stress, the root exudates, etc., even if the gene in question was tolerance to herbicide can become important. The insects and pathogens which normally inhabited the weeds the herbicide would have killed now leaving only the transgenic plants in the vast area will by nature try to domesticate themselves on their non-host GMO. This has always happened even before GMOs hit fields when new plant types were introduced with a totally different pattern of vegetative and reproductive phases. The insects which inhabited on the old type crop at flowering stage looked for inhabiting on a crop the pest was never known to inhabit. This may not happen in the case of genetically regulated host-pathogen interactions but not uncommon. When oilseed Brassica fields were sown early and sprayed with the insecticides, the black aphids which are normally not known to prey on wheat would do so. The selection pressure on the insect population could throw up a new strain of aphid which would equally proliferate on wheat. Such pressures will be more with the GMO. In order to look for this type of "indirect" impacts one has to include data on the possible pests that prevailed in the area on the weeds and other vegetations on the field borders in the information bank. Only then can the question "What to monitor" can be expanded to many possible entities and traits.

How and when to monitor

Base line: A base line is that information which needs to be obtained from the environment on aspects one is likely to monitor (answers to "what"). Without a base line

information, there is no way one can monitor if there is any change at all. The questions of "how" and "when" do we monitor are the difficult questions that cannot be answered globally because a single ecosystem can also vary greatly in space and time. If the ecosystems were uniform, it would have been possible to enter into data sheet information on a certain trait and the monitoring team could measure or spot any effect the transgenic crop would have caused to it in contrast to the non-transgenic crop. Therefore, information on what the ecosystem was like before the transgenic was introduced commercially needs to be generated for at least last three to five years. To monitor any expected trait, one has to record many data points on a comparative plane to see if there is any trend of change due to the transgenic. Developing that base standard data set is therefore very crucial and has to be kept dynamic. That is, more than just one data on a ecosystem at one moment. For example, unless the monitoring team understands how much the population of a particular insect normally varies from year to year as the crop progresses, it would be impossible to know how to interpret a 30% drop in the insect number the year after a crop of Bt transgenic was planted (National Academy of Sciences, 2000). To know this, there is a relationship that has to be given to the weather parameters, its conduciveness during the current year for the insect population build up in comparison to the previous few seasons. The impact as solely due to the transgene should not get confounded by a different form of temporal and spatial variability in the region.

Thus, the most important tasks for PRM is to develop databank to establish what hazards can be posed in the environments including details on what the risk assessors have identified as less known information. Once an awareness of such directly relevant and /or less relevant or less known information is available, the risk assessors can decide which areas are more or less likely to involve a particular risk by preliminary observation at sample site and accordingly intensify the monitoring of that aspect for a fruitful PRM.

Why do we monitor

Do we monitor only for the presence of the gene? Or we looking for any degree of expression of the gene? Or are we concerned about what are the reasons which compel a monitoring? Is the gene product very crucial for the economy of the country but the product is perceived to be dangerous to human and animal population or the ecology? Are we interested in merely detecting the gene? Do we care what has the transgene done to the variety and its surroundings as well as its progeny? Is it likely to cause any allergic, toxic or hazardous to human beings?

At different times, at different locations, different purposes have to be looked into, which makes it necessary to see that monitoring has to rely on information and the purpose of information. In addition, if the transgenic has resulted in a different management of a crop agronomy, then we need to have data on which to base the alterations of the management. For example, if the expression of the Bt gene against an insect is to be monitored without the

usual practice of pesticide spray on the crop, it is necessary to develop the data set on the "refugia" crop again with reference to a base line, and monitor the pest to detect any signs of pressure on the insect to develop resistance to the Bt toxin.

How do we monitor

Finally, to do a PRM effectively, there should be a designed data entries which can detect both unexpected and unpredicted events and the events that are expected. Like the information on how long did the Bt corn take to decompose in the soil compared to the available information on refugia and base data on non-Bt corn is an example which one would not be looking for when the transgenic is with reference to pest resistance. In the first few years, such instances needs to be recorded extremely carefully to be prepared for the unexpected. This is real time monitoring when the crop is put into the field right from its first year to its commercialization. This on-course monitoring in the life of a transgenic provides inputs to take immediate decisions on the life of the transgenic or any agroecological production technology modification for eliminating any obvious risk elements observed.

The PRM, that is not quantifiable is the long-term strategy of monitoring. One cannot fix any generic yardsticks nor any exhaustive model on the information data that is good enough for monitoring the long-term effect of the release of a transgenic organism. A sui-generis system that facilitates a case by case analysis of the transgenic has to be developed in each situation.

In India, there is a four tier system of PRM, all of which have to be passed by the transgenic group step by step. Each step introduces an inbuilt monitoring aspect of multidimensional scanning of the input information vis-à-vis real data being generated. The steps are:

Step one : Approval by the Institutional Biosafety committee (IBSC)

Step two: Approval by the Review Committee on Genetic Modification (RCGM)

Step three : Approval by the Monitoring and Evaluation Committee (MEC) and

Step four : Approval by the Genetic Engineering Advisory Committee (Comrising of four Ministries)

Table 6.1 summarizes the extent of information the transgenic producing group needs to have before considering even a limited isolated field trial. It may look like the onus is entirely on the producer to provide information on the transgenic. But, it definitely is the base data about which the monitoring team can develop its own strategies on expecting any ill-consequences and biosafety as well as the unexpectedly unknown benefits from its release in the system. The focus is therefore on a set of key information that needs to be made available for assessment and evaluation of the biosafety with reference to a GMO during monitoring process. This set of information provides the base for the agency monitoring the biosafety before, during and after the GMO is released into an environment including the pre-release containment experiment after the GMO is developed.

Table 6.1: Basic information that needs to be generated for facilitation of monitoring the GMOs release related to biosafety assessment.

Particulars	**Information Sought**
Rationale for the development	Economic agronomic and other benefits,
Details of the molecular biology of GMOs (microorganisms, cell lines, plants, animals etc)	. Description of the host organisms . Source and sequence of transgene . Sequential block diagram of all trans-nucleic acid stretches inserted . Cloning strategy . Characteristics of inserted genes with details of sequences . Characteristics of promoters . Genetic analysis including copy number of inserts, stability, level of expression of transgenes, biochemistry of expressed gene products etc. . Transformation/cloning methods and propagation strategy (Microorganisms, plants and animals)
Laboratory, Green House Trials (for plants) and contained enclosure trials (for animals)	. Back-crossing methods for plants . Seed setting charateristics of plants . Germination rates of seeds . Phenotypic characteristics of transgenics . Organisms challenge tests where ever applicable . Effects of chemical herbicies for all herbicide resistant plants . Growth characteristics and general health of animals, measured through specific scientific parameters . Toxicity and allergenicity implications to human if any during handling of GMOs
Field trials in open environment	. For GM Plants, comparison of germination rates and phenotypic characteristics, using non-transgenics controls. . Study of gene flow of plants . Possibility of weed formation for GM plants . Invasiveness studies of plants and animals compared to non-transgenics used as controls . Possibility of transfer of transgenes to near relatives through out crossing./cross-fertilization . Implications of out crossing/cross-fertilization . Comparative evaluation of susceptibility to diseases and pests for plants and animals . For human food/animal feed, elaborate determination of composition and assessment of quality of transformed plants/fruits/seeds as well as animals as the case may be, with appropriate controls. Compositional analysis shall include near equivalence studies of all the major ingredients in GMOs so as to assess substantial equivalence with reference to non-transgenics. Change in the levels of allergenes, toxicants if any, beyond acceptable limits is a matter of food safety concern and such substances are

	unsuitable for commercial release. . Toxicity and allergenicity implications of transformed GMOs. This include micoorganisms, plants/fruits/seeds as well as animals, lab animal studies for food/feed safety evaluation is a requisite. . Handling procedures for allergenic substances . Agronomic evaluation for GM Plants . Economic evaluation for GM animals

Statutory regulation on provision of information to monitoring agencies

The power of monitoring agency should be in its responsibility in putting a stop to the release and if required, destroy the material if it is feasible. Such a responsibility therefore relies on the research output that produces the transgenic organism for providing the information relevant in addition to those relevant neither to the crop nor the gene, but the ecosystem. Then, it also becomes essential that the producer of the GMO link itself with other capabilities that provides data on those not directly associated with the gene or the GMO. In India, at least four sets of documents which are entirely information bank on the GMO being addressed to by the researching or commercializing agency. The documents are to be provided to different monitoring and evaluating agencies in specific formats (separately enclosed as Annexure) on

a. Information to IBSC/ RCGM for Import/ Exchange of GMOs and Products Thereof for Research Purpose
b. Information to IBSC/ RCGM to Carry Out Research for Development of r-DNA Products
c. Information to IBSC/ RCGM to Carry out Research for Development of Transgenic Plants
d. Half Yearly Report of the Institutional Biosafety Committee

It should be understood that no amount of information is "ENOUGH" to be assess 100% biosafety of the GMO being released or released. However, an honest disclosure of information and any other perceived information has to be recorded in the interest of human and environmental safety. An example of such information is, as under:

An example of information bank that needs to be generated project-wise by the monitoring agency (*Source: Nap et al,2003.)*

A. ***General information***

1. The name and address of the Researcher/Farmer/Agency
2. The title of the project
3. The area and location where the specific crop is sought to be gown:

B. ***Information about the normal crop/organism***

1. Scientific name :

   Genus :_____ species_____

   sub-species:

   Family :

   Particular variety targeted

   Or culture of the microorganism

2. Mode of reproduction : Sexual/Asexual/Vegetative

   Mating system : Self/cross/often cross/often self/sterile

   Generation time seed to seed or completion of one cycle (organism):

   _____days

   Seed to flowering :_____days

   Flowering to maturity _____days

   Sexual compatibility with other cultivated or wild plant species

3. Information on the survivability of the crop:

   Seed type

   Dormancy if any, etc

   Resting stage of the organism (in case of micro-organism)

4. Information concerning dissemination and seed dispersal of plant: type, extent and factors affecting dissemination

5. The geographic distribution of the plant and centre of origin

6. Natural habitat of the plant or organism

7. Common weeds recorded as problem weed with the crop in the region

8. Information on the weed (1-n)

   family

   mating system

   habit

   known ideal habitat

   maturiry and days to flowering

   seed-seed

   type of seed

9. Diseases of the crop known prevailing over last 5 years and the maximum and minimum distribution (disease-wise /tabulated year wise)

10. Insect pest information along with maximum and minimum infestation data over the last five years along with the plant part targeted by the insect (insect wise data – tabulated year wise)

11. Predator pests with known affinity to the crop including birds and grazing animals
12. Any known allergenicity or toxicity naturally existing as a product of the on any significant interactions of the plant with organisms other than plants in the ecosystem where it is usually grown, including toxicity to humans, animals and other organisms

C. ***Information about the transformation tool and materials***

13. A description of methods used for genetic modification
14. The nature and source of the vector used
15. The size, function and donor organism(s) of each DNA sequence inserted

Information relating to the genetically modified organism

16. A description of the trait(s) and characteristics of the GM plant which have been modified
17. Information on sequences inserted or deleted: size/structure, copy number of insert, information on any vector sequences or foreign DNA remaining in the GM plant. The size/function of any deleted regions. Cellular location of insertion (eg. chromosomal, mitochondria, chloroplast etc.)
18. Information on the expression of the insert and its genetic stabiliy: expression and parts of the plant where expressed
19. How does the GM plant differ from the recipient plant in mode/rate of reproduction, dissemination, survivability
20. The potential for transfer of genetic material from the GM plants to other organisms
21. Information on any toxic/harmful effects on human health and the environment arising from the genetic modification
22. The mechanism of interaction between the GM plants and target organisms
23. Any potential significant interactions with non-target organisms
24. A description of detection and identification techniques for the genetically modified plants
25. Information about previous releases of the GM plants

Information relating to the site of release

26. The location and size of the release site or sites
27. A description of the release site ecosystem, including climate, flora and fauna
26. Details of any sexually compatible wild relatives or cultivated plants present at the release sites
27. The proximity of the release sites to officially recognised biotopes or protected areas

Information relating to the release

28. The purpose of the release
29. The foreseen dates and duration of the release
30. The method by which the GM plants will be released
31. The method for preparing and managing the release site, prior to, during, and after the release
32. The approximate number of GM plants (or plants per m2) to be released

Information on the control, monitoring, post-release plans and waste treatment plans

33. A description of any precautions to minimise or prevent pollen or seed dispersal from the GM plant
34. A description of the methods for post-release treatment of the site or sites
35. A description of post-release treatment methods for the GM plant material including wastes
36. A description of monitoring plans and techniques
37. A description of any emergency plans

Information on potential environmental impact of the release of the genetically modified plants

38. The likelihood of any GM plant becoming more persistent or invasive than recipient plants
39. Any selective advantage or disadvantage conferred to other sexually compatible plant species, which may result from genetic transfer from the genetically modified plant
40. Potential environmental impact of the interaction between the GM plant and target organisms
41. Any possible environmental impact resulting from potential interactions with non-target organisms

Monitoring Release 0f GM Microorganisms

Genetically modified microorganisms (GMMs) are promising for many environmental and agricultural applications, including bioremediation of toxic chemicals and bio control of plant diseases. It is important to ensure that when these organisms are released into nature that they do not harm the environment or human health. Therefore, new GMM products are thoroughly assessed for potential risks before they are approved for widespread application. One important aspect of risk assessment is the actual monitoring of the fate of the GMM in nature (i.e. survival, dispersal, etc.). Specific methods are required to monitor the GMM apart from the natural microorganisms present in the environment. For example, a single gram of

soil contains billions of microbial cells comprising thousands of distinct genotypes. In addition, the monitoring methods should be sensitive to enable low numbers of cells to be counted, since the GMM population could increase in number should the environmental conditions prove more favorable. Considerable research efforts have been directed towards development of sensitive and specific tools for environmental monitoring of GMMs.

Before the microorganism is released, it is essential that it is monitored through its developmental and testing procedures where, the microbes are subjected to 'contained use'. Examples of typical contained use situations are laboratories, animal houses used, for example, for breeding GM mice, plant growth rooms and glasshouses, industrial fermenters used for large scale production, e.g. enzymes for washing powders. Contained use is defined as any activity in which organisms are genetically modified, or in which GMOs are cultured, stored, used, transported, destroyed or disposed of and there are barriers in place to limit contact with humans and the environment, so as to provide a high level of protection. These barriers can be physical, biological or chemical, or a combination of these. Separate regulations cover deliberate release into the environment, food safety and other product approval issues. Thus, the definition does not keep "physical structure" as an essential containment feature where, any activity in which micro-organisms are genetically modified …and for which specific containment measures are used to limit their contact with the general population and the environment (CEC, 2000). This is also reflected in the newly released open book entitled "Biological confinement of genetically engineered organisms" by the Board on Agriculture and Natural Resources, USA (2004). When the quantity of the microbial culture does not exceed 10 lts and is non-commercial in nature, the GMM that is then for a purpose of training or research or non-industrial usage is categorized at a relatively lower grade of A while rest of the GMM is categorized as B. In the case of microbes, any unintended release which may have any bearing on human or animal health is for the monitoring purposes is to be regarded as an "Accident" so that appropriate measures are adopted to inactivate the GMM and the community is cautioned on an alert.

Classification of the GMMs

How are the risks of contained use assessed and classified?

Preparing a scientific assessment of risk to human health and the environment can be a substantial workload. CUR 2000 lays down the steps to be taken, which in simplified form include:

a. identification of any harmful properties of the organisms donating and receiving the genetic material, the intermediary or vector, and the inserted genetic material itself, and any harmful properties arising from any alteration made to the receiving organism's properties by the genetic modification
b. consideration of other relevant legislation, particularly in the way that it classifies the risks of the organisms to be used

c. consideration of the activity (for GMMs, in the context of the relevant environment), particularly non-standard aspects requiring individual attention

d. selection of appropriate containment measures from a table which arranges them in numbered columns. For GMMs, classification to the appropriate risk level, which equals the highest column number corresponding to any individual containment measure selected

Requirements of hygiene & protective measures

1. For genetically modified micro-organisms in Category I, the principles of good microbiological practice, and the following principles of good occupation safety and hygiene, shall apply which involves

(i) keeping workplace and environmental exposure to any physical, chemical or biological agent to the lowest practicable level;

(ii) engineering control measures at source and to supplement these with appropriate personal protective clothing and equipment when necessary;

(iii) testing adequately and maintain control measures and equipment;

(iv) testing, when necessary for the presence of viable process organisms outside the primary physical containment and provide training to personnel working in the containment.

2. In addition to these principles, the containment measures shall be applied, as appropriate, to contained uses of genetically modified micro-organisms in Group II so as to ensure a high level of safety.

3. The containment measures applied shall be periodically reviewed by the user to take into account new scientific or technical knowledge relative to risk management and treatment and disposal of wastes.

Re-notification of all Premises/Activities:

When undertaking GM procedures for the first time each centre must register with the IBSC specifying their first activity. For those centres which will only undertake Category 1 activities at containment level 1 this may be the end of their contact with the IBSC. Only activities of Categories 2 and above need to notify the IBSC of each new activity.

Monitoring the GMM in environment

The GMM can be effectively monitored against the parameters given below as information generated on the GMM:

A. Characteristics of the donor, recipient or (where appropriate) parental organism(s)

B. Characteristics of the modified micro-organism

C. Health considerations

D. Environmental considerations

A. Characteristics of the donor, recipient or (where appropriate parental organism(s)

- names and designation;
- degree of relatedness;
- sources of the organism(s);
- information on reproductive cycles (sexual/asexual) of the parental organism(s) or, where applicable, of the recipient micro- organism;
- history of prior genetic manipulations;
- stability of parental or of recipient organism in terms of relevant genetic traits;
- nature of pathogenicity and virulence, infectivity, toxicity and vectors of disease transmission;
- nature of indigenous vectors: sequence,frequency of mobilization,specificity,presence of genes which confer resistance;
- host range;
- other potentially significant physiological traits;
- stability of these traits;
- natural habitat and geographic distribution. Climatic characteristics of original habitats;
- significant involvement in environmental processes (such as nitrogen fixation or pH regulation);
- interaction with, and effects on, other organisms in the environment (including likely competitive or symbiotic properties);
- ability to form survival structures (such as spores or sclerotia).

B. Characteristics of the modified micro-organism

- the description of the modification including the method for introducing the vector-insert onto the recipient organism or the method used for achieving the genetic modification involved;
- the function of the genetic manipulation and/or of the new nucleic acid;
- nature and source of the vector;
- structure and amount of any vector and/or donor nucleic acid remaining in the final construction of the modified micro-organism;
- stability of the micro-organism in terms of genetic traits;
- frequency of mobilization of inserted vector and/or genetic transfer capability;

- rate and level of expression of the new genetic material. Method and sensitivity of measurement;
- activity of the expressed protein.

C. Health considerations

- toxic or allergenic effects of non-viable organisms and/or their metabolic products;
- product hazards;
- comparison of the modified micro-organism to the donor, recipient or (where appropriate) parental organism regarding pathogenicity;
- capacity for colonization;
- if the micro-organism is pathogenic to humans who are immunocompetent:

(a) diseases caused and mechanism of pathogenicity including invasiveness and virulence;
(b) communicability;
(c) infective dose;
(d) host range, possibility of alteration;
(e) possibility of survival outside of human host;
(f) presence of vectors or means of dissemination;
(g) biological stability;
(h) antibiotic-resistance patterns;
(i) allergenicity;
(j) availability of appropriate therapies.

D. Environmental considerations

- factors affecting survival, multiplication and dissemination of the modified microorganism in the environment;
- available techniques for detection, identification and monitoring of the modified microorganism;
- available techniques for detecting transfer of the new genetic material to other organisms;
- know and predicted habitats of the modified micro-organism;
- description of ecosystems to which the micro-organism could be accidentally disseminated;
- anticipated mechanism and result of interaction between the modified micro-organism and the organisms or micro-organisms which might be exposed in case of release into the environment;
- known or predicted effects on plants and animals such as pathogenicity, infectivity, toxicity, virulence, vector of pathogen, allergenicity, colonization;

- known or predicted involvement in biogeochemical processes;
- availability of methods for decontamination of the area in case of release to the environment.

A brief description on methods to detect microbes for GM from environment

Specific methods are required to monitor the GMM apart from the natural microorganisms present in the environment. For example, a single gram of soil contains billions of microbial cells comprising thousands of distinct genotypes. In addition, the monitoring methods should be sensitive to enable low numbers of cells to be counted, since the GMM population could increase in number should the environmental conditions prove more favorable. Considerable research efforts have been directed towards development of sensitive and specific tools for environmental monitoring of GMMs. According to Jason et al. 2003, the methods are divided into the following categories of desired information below:

1. Number of culturable GMM
2. Number of total GMM cells, regardless of their activity or culturability
3. In situ visualization of GMM distribution
4. GMM activity
5. Presence of genetically modified DNA
6. Plasmid transfer

1. Enumeration of culturable GMMs

Selective plate counting: A simple, sensitive and cost effective method for quantification of culturable cells is selective plate counting. This technique relies on the selective growth of the GMM on agar medium that contains a compound that inhibits growth of the natural microbial population. This compound could be, for example, an antibiotic or a heavy metal. Due to concern about the spread of antibiotic resistance to pathogenic microorganisms, while it is strongly recommended that a GMM with antibiotic resistance selectable marker not be released into the environment, many microorganisms are intrinsically resistant to some antibiotics. Since intrinsic resistance is a natural trait, we do not object to the use of intrinsic antibiotic resistance markers for tracking of GMMs on selective medium, so long as the antibiotics are not important for clinical or veterinary use. For example, rifampicin, and kanamycin are useful antibiotics for selection purposes. The reason that we recommend continued use of selective plating for tracking of GMMs is that the methods are routinely used in most microbiology laboratories and they are cheap and sensitive. While opinions of the kind that kanamycin as an antibiotic does not create any utility concerns of biosafety as most of the animal and human pathogenic bacteria are already resistant to the same and are anyway not prescribed as antibiotic treatment.

An alternative to antibiotic selection is the use of heavy metals in the medium, such as mercury. However, this requires handling of hazardous compounds (i.e. mercury) in the laboratory and should be avoided. In some cases semi-selective plating may be used. This involves for example using media where the GMM is able to grow but only a small portion of the indigenous microorganisms are capable of growth. For example, if the GMM has been modified to degrade and to be able to use an environmental pollutant as sole carbon and energy source, this compound can be added to minimal plates used for bacterial enumeration. Depending on the compound the amount of background varies. Additional identification methods (see below) can be used to distinguish between GMMs and background.

Non-selective plate counting*:* In some cases it may be preferential to use non-selective plate counting to enumerate GMMs in environmental samples. The difference with this method, compared to that above, is that it does not rely on incorporation of an inhibitory compound into the agar medium. Instead the GMM is distinguished on agar plates on the basis of a unique phenotype. This phenotype could be a metabolic property or the ability to luminesce or fluoresce (Table 7.1). The principles are otherwise similar to that of selective plate counting above. The primary disadvantage with non-selective plate counting is that there is usually a large background growth of colonies of the natural microbial population, since these cells are not inhibited by incorporation of a selective compound. However, careful design of cultivation media and use of sophisticated screening techniques can in some cases alleviate this problem. In general, non-selective plate counting is most useful for counting of GMMs when they are relatively abundant and extreme sensitivity is not required.

In both the procedures, the monitoring laboratory needs to keep a repository of the original cultures for comparison of the colony forming unit (cfu) values of the standard cultures. The investment is worth the effort as the infrastructure required is not prohibitively expensive. The sampling itself has to be done in periodic intervals from potential areas near the industrial units or agricultural farms which employ biologicals for control of pests, pathogens or for processed products. Representative samples of a given environment in the suspected or routinely selected region likely to be containing the gene constructs or the GMMs needs to be taken and the sample source location and identity recorded. A sample size can be very small like 10g soil, 10g plant tissue, 10 ml water or 10g of a known agri-produce.

2. Enumeration of total number of GMMs, regardless of their activity or culturability

Nature is comprised of a variety of ecosystems, varying in complexity. Many ecosystems, such as most soil ecosystems, are harsh environments and introduced GMMs may become stressed when released to these ecosystems. Many microorganisms are known to react drammatically to different stress conditions by turning off synthesis of some proteins and initiating synthesis of others. This could partly explain the phenomenon of viable-but non-culturable (VBNC) cells that has been observed for certain bacteria in natural ecosystems. When bacteria are stressed, or in a VBNC state, it is difficult to get them to grow on

traditional laboratory media. Therefore, although these cells may still be present and viable and thus able to exert an effect on their local environment, they may not be counted by traditional methods based on cultivation, such as plate counting methods. A related problem is that starved cells have repressed metabolic activity and low energy reserves. Therefore, methods are necessary to enumerate cells, independently of their culturability or activity.

Table 7.1. Examples of non-selective biomarkers and their corresponding colony phenotypes (source : Jansson et al. 2003)

Marker gene methods (encoded protein)	Substrate/Requirement	Colony phenotype	Detection
LacZ, β-galactosidase)	5-bromo-4-chloro-3-indoyl-β-Dgalactopyranoside (X-gal)	Blue color	Visual
lacZ	Fluorescein digalactoside+UV	Fluorescence	CCD camera
Gfp (Green fluorescent protein)	Blue light*	Fluorescence	CCD camera, visual
luc (eukaryotic luciferase)	Luciferin	Luminescence	CCD camera, Visual, Photographic film
luxAB (bacterial luciferase)	*n*-decanal *luxCD & luxE* genes	Luminescence	CCD camera, Visual, Photographic film
xylE (catechol 2,3- dioxygenase)	Catechol	Yellow color	Visual
gusA β-glucuronidase)	X-GlcA (5-bromo-4-chloro-3-indoyl-β-D-glucuronide)	Blue color	Visual

*UV light can also be employed, but due to the potential for UV-induced mutations, the exposed colonies should not be used in subsequent studies. Bacteria which are known to readily express GFP encoded by a multicopy number *gfp*-vector easily form bright green colonies that can often be seen as yellowish-green colonies under normal illumination (daylight). In some cases a "position effect" of *gfp* integration into the bacterial chromosome is observed leading to unusually bright fluorescence, although the reasons for this effect are currently not known.

An aspect that the monitoring agency may seek to be adopted is that the GMMs should be tagged with GFP genes as the marker system especially on microbes known to be broad host ranged or saprophytic in nature. This regulation would enable the enumeration of the GFP tagged contaminants from the samples by flow cytometry which does not require the need for culturing and staining (Tombolini and Jansson, 1998). Can such a regulatory rule be made mandatory right at the time of approving research on the microbe by the regulatory authority?

A caution with such techniques in monitoring that is actually done to decide the future course of action on the gene or the GMM in question is to carefully analyze the samples using population statistics in sampling and general statistics in working out the background absorption by non-target particles and cells. However, the process can be standardized and is a very fast technique. Another important aspect of this method is the ability to detect the size and shape of the fluorescing particles which can be classified through software. This allows multiple contaminant microbe detection

How do we enable monitoring for the GMM or other non-targeted microbes by adopting this technique? Two monitoring indicators need to be introduced to enable proper verification of the results documented during review by the monitoring agency. One is with respect to proper statistical analysis of the data on escapes or horizontal spread. The other one is survey of available information regarding the physical shape and size of the GMM being released and also the other known microbes that could have the transgene passed into them upon its release into the environment.

3. ***In-situ* enumeration of the bacterial cells using scanning confocal and stereo fluorescence microscope** :

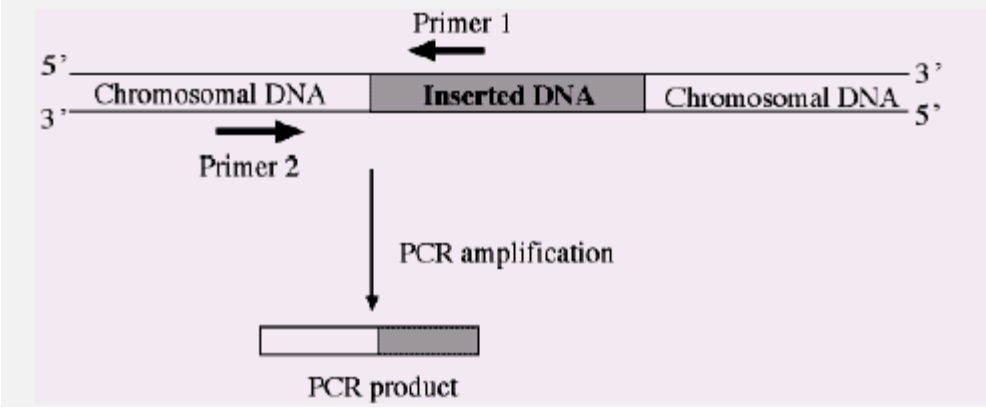
Scanning confocal laser microscopy (SCLM) is a particularly useful non-invasive technique for the detection and localization of fluorescently-tagged GMMs *in situ*. Microbes synthesizing the green fluorescent protein can be readily detected using SCLM. The technique can be as usefully adopted as the flow cytometric technique. Again a statistical interpretation of data is a necessity using microscopic fields and collected samples as units of sampling variability. The technique also does not require any culturing of the microbe. The method can be used for visualizing bacteria from other environments as well. Plant leaf associated bacteria can be divided into epiphytic (surface associated) and total cells. Of these the epiphytic cells can be easily separated from the leaves avoiding any interfering plant cells. The endophytic contaminants can be visualized through SCLM from plant tissue extracts or smears. Fluorescence stereomicroscopy is a relatively new technique for gross visualization of the pattern of colonization of fluorescent (GFP-tagged) microorganisms on samples such as plant tissues. The stereomicroscope can also be equipped with a sensitive CCD camera for *in situ* visualization of luminescent cells on the sample.

4. GMM activity

Often it is the metabolically active fraction of a GMM population that is of the most interest, considering that the metabolically active cells have potential to exert an effect on their surrounding environment. It is also the metabolically active cells that are best equipped to perform the intended function for which they were designed and released (for example, bioremediation or biocontrol). However, bacteria in nature are not always metabolically active since many environments, such as sandy soil, are harsh with few available nutrients.

Therefore, the cells can expend their energy reserves and become quiescent (i.e. in a resting state) until nutrients become available. By contrast, other ecosystems, such as a plant root, may leak nutrients that can be utilized for metabolism by the released GMMs. With appropriate modification of the sample of the environment one can monitor the marker genes such as luminescent marker for luciferase activity (*luc*, or *luxAB*-tagged cells) by luminometry or CCD camera and image analysis. The activity can be enhanced by pretreatment of the samples for which depending on the marker gene, different protocols are available (Jasson et al. 2000). Quenching is a problem that is often encountered when measuring light output in an environmental sample. For example, soil particles and humic acids can quench light emitted from cells resulting in a decrease in the light yield measured by the instrumentation. A pretreatment protocol needs to be followed to enhance the probability of expression of light emission signals. Alternatively, light-emitting cells can be detected directly on plant surfaces, for example, using a sensitive photon counting camera or a CCD camera.

5. Presence of genetically modified DNA



A GMM by definition has a genome that has been altered by genetic manipulation. Sometimes the change in the genome is sufficient as a target for specific monitoring of the GMM using nucleic acid-based approaches. If a novel DNA sequence has been inserted into the GMM, this sequence can be detected by use of DNA probes. Alternatively, the novel sequence can be detected by PCR amplification. Often it is advantageous to design primers for PCR amplification that amplify across junctions of introduced DNA fragments to increase specificity of detection as below:

6. Plasmid transfer

A GMM may be constructed by engineering of the chromosome or by introduction of a plasmid containing genes encoding desired traits. Plasmids are extrachromosomal genetic elements, and some plasmids can be transferred to other microorganisms. The potential for

plasmid transfer from the GMM to known recipients or to members of the indigenous microbial community can be monitored directly by tagging the mobile DNA molecules with appropriate marker genes. For example, different GFP variants, with different excitation and emission spectra, may be used to follow donor, recipient and transconjugants in environmental samples, simultaneously. This can be achieved by tagging the conjugative plasmid with a cassette comprising one constitutively expressed fluorescent marker, and the recipient being chromosomally tagged with another fluorescent marker gene. In this case the donor cells will appear as emitting light in one color, the recipient cells in another, and the transconjugants as a combination of both colors. These methods, while developed specifically for plasmid conjugation studies may be modified with little effort to also be useful in studies of transduction or transformation. For example, the -galactosidase promoter, P*lac*, can be fused to the *gfp* gene on the plasmid of interest. The GMM should also contain the *lacI* gene, encoding the lac repressor protein, LacI, integrated into its chromosome. In this case, the P*lac* promoter will be repressed in the GMM and no GFP will be produced. However, should the plasmid be transferred to an indigenous microorganism lacking the *lacI* gene, the *lac* promoter will be active and the GFP protein synthesized. Green fluorescent transconjugants can then be detected by microscopic methods as described above.

Additional information

The European Commission Biotechnology Programme, DGXII, has recently sponsored the publication of a series of booklets related to the use of marker and reporter genes in microbial ecology that have direct relevance to the methods presented in this manual. The books were written by the MAREP Concerted Action of scientists, consisting of 26 scientific experts from 11 different countries. More information can be found on the MAREP website.

(Website: http://www.sh.se/marep/marep.html)

Booklet titles:

- Marker genes as tags for monitoring microorganisms in nature
- Reporter genes for monitoring microbial activity and/or the environment
- Monitoring methods for specific microorganisms and microbial communities in nature
- Biosafety aspects of marker and reporter genes

5. Surveillance and Emergency Planning

The aspect of surveillance and emergency planning generally a review phase. The action aspect of the planning comes into force only during accidents. Therefore, surveillance is basically that part of monitoring where a generic view point of the institutional mechanism is incorporated for improved performance of the enforcement of the biosafety regulations..

What requirements must be met while the activity is being carried out?

A. ***Under Containment***

Standards of containment and control must be commensurate with, and determined by, the risk assessment. The appropriate standards can be identified from Schedule 8 to CUR 2000 together with the risk classification (1 to 4) arrived at in the risk assessment of a contained use activity. These standards must be maintained. Good microbiological practice and good occupational safety and hygiene (GOSH) should be taken into account.

CUR 2000 referred earlier (EU guidelines, 2000) requires all GMMs to be inactivated before their disposal. The required level of inactivation is related to the risk. For the more hazardous GMMs, 100% 'kill' is required. In intermediate cases, chemical disinfection, typically giving a 10 fold reduction in viability (99.999% kill), may be adequate. For low risk activities, inactivation as part of another processing step, such as the extraction of a product, may be sufficient - provided that the required level of inactivation is shown to be met consistently. In the lowest risk cases, it may be enough that the organisms are biologically incapable of survival after discharge from a contained use facility, so that no harm can result to humans or the environment. However, to use this passive inactivation approach, permission must be obtained from the Institution's Biosafety Committee, which will need to carry out an evaluation. After inactivation, the waste remains subject to waste and pollution law that applies to any waste - see the ACGM Compendium of Guidance, Part 1, paragraph 76, for relevant legislation.

The principles of good microbiological practice and good occupational safety and hygiene (GOSH) are:

- keeping workplace and environmental exposure to any GMMs to the lowest reasonably practicable level
- exercising engineering control measures at source and supplementing these with appropriate personal protective clothing and equipment where necessary
- testing adequately and maintaining control measures and equipment
- testing, where necessary, for the presence of viable process organisms outside the primary physical containment
- providing appropriate training of personnel
- formulating and implementing local codes of practice for the safety of personnel, as required
- displaying biohazard signs where appropriate
- providing washing and decontamination facilities for personnel
- keeping adequate records
- prohibiting in the work area eating, drinking, smoking, applying cosmetics or the storing of food for human consumption

- prohibiting mouth pipetting
- providing written standard operating procedures where appropriate to ensure safety
- having effective disinfectants and specified disinfection procedures available in case of spillage of GMOs
- providing safe storage for contaminated laboratory equipment and materials where appropriate.

B. In open environment

For the appropriate regulation of biosafety, the key issue to resolve has been, and will remain, 'when is safe sufficiently safe?' This requires appropriate science for determining what is meant by 'safe' and judgement for deciding the meaning of 'sufficiently'. The current era of genomics, proteomics, etc. is delivering technologies that will allow the measurement of gene expression at the RNA and protein levels, as well as molecules of each specific metabolite in a plant. Future regulation aimed at 'absolute safety' may eventually demand such measurements as a routine requirement based on the premise that everything that can be measured should be measured, irrespective of its potential (ir)relevance. The baseline for 'safe' should be comparison and the judgement of 'sufficiently' should take the comparative risk into account. The judgements made during a comparative assessment should represent the concerns of the public. However, caution should be observed when items in regulatory procedures are put in place solely for the purpose of enhancing public confidence. The role of regulators must be to recognize when impacts of GM crops might become unacceptable and to require changes to existing or GM farming practices to obtain the balance that society demands. But, what a given society wants and how much it might be willing to pay for additional assurances is unknown.

In this context, the impact of regulation is going to be a crucial issue that must not be forgotten. It is important to emphasize that the regulation of risk is currently turning into a risk of regulation. The regulatory process itself may already cause one of the greatest risks (Brown, 2001). The level of scrutiny imposed is unprecedented for the products of plant breeding. As regulations become impractical, compliance with them becomes less controllable and they are likely to become considerably more costly than anticipated. The plant breeding industry, in general, does not have the resources for GM crop material to be assessed in the same detail as a pharmaceutical. The cost of meeting regulatory requirements is currently a significant negative impact on the release of GM crops compared to the release of cultivars from traditional breeding. Excessive regulatory reviews will frustrate and curtail research and application to such an extent that only a few large multinational companies can afford to make progress. In this manner, over-regulation will help to promote a situation that is a concern of many: corporate control of agriculture (Dawkins, 2002). This trend is already clearly apparent and may result in the creation of a single (or a few) companies dominating

world food production and increasing world dependence (Dawkins, 2002; Josling and Nelson, 2001).

A potentially even larger danger of the trend toward zero-risk in current regulation is that a similar risk scrutiny will be imposed on the activity of traditional, non-GM plant breeding. The results of a recent National Academy of Sciences survey (NAS, 2002) already suggests that conventional crops may pose undesired environmental risks and should be monitored (Gewin, 2002). This would basically be the end of plant breeding as we know it, and dramatically affect the future of plant science. Such ends do not seem to justify the means. Plants, crops and innovation in crops and crop growing will remain essential for global well being in the future. After release of a GM crop plant, therefore, the surveillance should use the basic information we discussed earlier in commercial release permission related proforma and field trial release proforma. Built on that should be to generate the information on the following aspects:

1. The Reference No. of the GM released as per the National Permit (NBC, Bangladesh for example)
2. Applicant's address, date of release and date when the field release monitoring report was produced
3. Dates when monitoring was carried out:

   (Here, the dates when the monitoring was carried out during and after the trials. If monitoring was carried out at frequent intervals, each item should be mentioned with summarized outputs between the dates)
4. Report on actual monitoring of the release

   Report on the outcome of environmental and biosafety monitoring carried out during the release. The report should focus on whether the release progressed as planned and if not, the reasons for this any environmental effects observed. Some details about how the monitoring was carried out should be provided. The statements should also indicate whether risk mentioned in the original application were analyzed and data provided.
5. Report on post-release monitoring

   Report on the post release monitoring describing the effects of the release on the environment, implications for the assessment of damage to the environment being caused by subsequent releases of the same GMO or the marketing of a product consisting of or including such GMO.
6. New information on risks of damage to the environment

   Describe any new information with regard to any risks to damage to the environment which has become available since the release and how this information affects the previous risk assessment.

7. Investigations for the predicted behavior of the genetically modified maize

   Data on the possible effects on other cohabiting plants and animals in the crop ecosystem has to be recorded as a routine to keep surveillance of any ill effects such as the monarch butterfly case in maize.

8. Origin and function of each constituent part of the insert in the GMO

- As a matter of survey, data on the plasmid used as the binary vector of the transgene and its promoter should be maintained for any possible consequence of the plasmid sequences expressing or integrating in the plant.

9. Potential for genetic transfer and exchange with other organisms

   Maize has no sexually compatible wild or weedy relatives in Europe. Sexually compatible plants (genera *Zea* and *Tripsacum*) are present only in Mexico and Guatemala.

   Therefore, maize can not exchange genetic material via pollen with other plants in Europe.

10. Marker genes and their removal

Gene constructs are linked to marker genes both for the direct transformation of protoplasts and for the transformation by means of *Agrobacterium tumefaciens* in order to be able to identify safely and rapidly, after having passed partial steps of the transformation, those cells (in the direct transformation of protoplasts the plant cells; in the transformation with the aid of *Agrobacterium tumefaciens* at first E. coli, subsequently *Agrobacterium tumefaciens* and later on the plant cells) into whose genome the DNA construct has been inserted. Certain antibiotic resistance genes of bacterial origin (in most cases the nptII or hph gene) are commonly used as selection marker genes for the last step which will be inserted into suitable Ti plasmid vectors together with the target gene construct. However, in the transformation procedure with *Agrobacterium tumefaciens*, such antibiotic resistance genes from vector segments may be occasionally transmitted to the plant genome which are located outside the DNA comprising target gene construct and selection marker gene and inserted into the Ti segment and possibly have served the selection of bacteria in the first and second steps.

Antibiotic resistance genes used as markers for genetically modified plants have reached public awareness. They have raised the concern whether horizontal gene transfer from the plant material to micro-organisms may lead to an increased level of resistance to micro-organisms of medical and veterinary use and, therefore, compromising the therapeutically use of antibiotics. This concern is fuelled by the experience that the extensive use of antibiotics for medical and veterinary purposes and as growth promoters for farm animals has lead to increased spreading of antibiotic resistance genes in the microbial population.

Thus, there is the need for science based assessment of possible adverse effects of antibiotic resistance marker genes in genetically modified plants.

11. Evaluation of the biological safety of the antibiotic resistance genes in the genome of gm plants

In the evaluation of the biological safety of antibiotic resistance genes in the genome of transgenic plants, it is of principal importance to relate the probability of transformation of soil and enteric bacteria by the antibiotic resistance genes released from the genome of transgenic plants to the probability of transfer of such antibiotic resistance genes by conjugation from one bacterium to the other.

12. **Administrative tasks during contained use activities in surveillance and emergency handling**

The risk assessment must be reviewed and revised as necessary, and records must be kept. A risk assessment should be reviewed if there is any reason to suspect that the initial assessment is no longer valid because of a significant change in the activity (CUR 2000), such as a change of scale of operation, containment measures, waste treatment procedures, or the availability of new information concerning the organism. Where new information, which may have significant consequences for the risks of a notified activity, becomes known, the IBSC must be informed .

The plan and its revisions must be made known to the emergency services and any body liable to be affected, and made available to the public. Any accidents resulting in significant and unintended release of GMOs must be notified immediately to IBSC, including the details.

Records of risk assessments should be kept for at least 10 years from the date that the work covered by the risk assessments finished.

Accidents and Emergency plans

Notifying accidents

1 Regulations place the responsibility on centres to immediately notify the Competent Authority of accidents, as defined in the regulations, involving genetically modified organisms. There may be situations where as well as notifying the Competent Authority under GMO regulation, the IBSC also requires notification , for example if a person were to require hospital treatment. This guidance aims to explain what should be considered to be an accident for the purposes of the GMO(CU) legislation; what information should be included when notifying an accident to the competent authority; who to contact; and what the CA will do with the information provided in the accident notification.

What is an accident?

An accident with reference to GMO is an incident involving a significant and unintended release of genetically modified organisms in the course of an activity involving genetic modification which presents an immediate or delayed hazard to human health or the

environment. Therefore, an accident is where a GMM is released in such a way that it poses an immediate or delayed risk to human health or the environment, or where a GMO (other than GMM) is released in such a way that it poses an immediate or delayed risk to human health. Accidents which result in release of GMMs and GMOs from primary containment, but not the laboratory or building may therefore constitute an accident, depending on the nature of the GMM or GMO.

Situations, which might constitute an accident, depending on the organisms involved, their mode of transmission and the nature of the accident, might include:

- the spillage of any Category III GMM outside of a microbiological safety cabinet (MSC) or other primary container;
- a major spillage of a Class 3 GMM within a MSC;
- the spillage of any category II and III GMM outside of a MSC or other primary container, where it is thought likely that an individual or the environment could have been exposed during the spill or during decontamination;
- the release or escape of a GMO, other than a GMM which could cause harm to human health, for example by acting as a novel disease reservoir;
- infection (classical) of a person with a (replication competent) GMM, as this constitutes a significant and unintended release.

Spillage or release of Category I GMM is unlikely to count as an accident as class 1 GMMs are unable to pose a risk to human health or the environment. If you are in any doubt as to whether you need to notify the Competent Authority, please contact the inspection team. Please note that any intention to release a GMO is subject to the Genetically Modified Organisms (Deliberate Release) Regulations 2002.

What information do you have to provide?

Where an accident occurs, the person undertaking the activity involving genetic modification shall forthwith notify the competent authority of the accident and shall provide the following information, which should subsequently be kept in public information :

- the circumstances of the accident;
- the identity and quantity of genetically modified organisms concerned;
- any information necessary to assess the effects of the accident on the health of the general population and on the environment; and
- any measures taken in response to the accident.'

What will the CA do with the information?

The Notification Officer will circulate the information provided to all members of the IBSC. and also places duties on the Competent Authority where it is informed of an accident. After taking remedial measures, the IBSC should deliberate on the -

- information on the circumstances of the accident; the identity and quantity of GMOs concerned and the measures taken in response to the accident;
- information on the effectiveness of the measures taken in response to the accident; and
- an analysis of the accident, including recommendations to limit its effect and to avoid similar accidents in future.

This means that concerned inspectors will need to investigate the accident to obtain all the information to make recommendations to avoid similar accidents and to share the lessons learnt in public. Therefore, IBSC should regard any attempt to avoid notification of an accident as a serious matter.

Emergency Plans

An emergency plan must be drawn up where the risk assessment indicates that, as a result of any foreseeable accident, the health and safety of persons outside the premises may be seriously affected or if there is risk of serious damage to the environment. Such a plan is unlikely to be necessary for most small scale activities or those involving low risk organisms.

The plan must specify

a. Methods specific to the GMO for procedures to control the GMO in case of unexpected spread.
b. Method to decontaminate or eliminate the effects of an accident
c. Method for disposal of sanitation of plants, animals, soils etc. that were exposed during the accident or spread

Health Surveillance

All workers undertaking genetic modification activities must register with the Institutional health services or any linked medical services agency as a matter of right. Following registration, health surveillance should be undertaken where this is considered appropriate.

Records

Departments must maintain various records relating to genetic modification work, history of accidents with respect to the GMO. The records must be kept whilst the work is being carried out and thereafter for at least 10 years from the date the work ceases. Records must be made available to the authorities when requested.

Training and Supervision

Supervisors must ensure that all workers for whom they are responsible are competent to carry out their work safely and that they receive an appropriate level of supervision.

Deputizing arrangements must be made to cover times when the supervisor is not available. Procedures should be in place to ensure new workers are familiar with the local codes of practice and the correct use of laboratory equipment. On the job training is important. Each new worker should be trained by staff familiar with the microbiological techniques involved as soon as possible and before the worker starts. Familiarization by means of individual discussion with each new entrant to the laboratory is advised. Training must specifically address safety issues and include discussion of the risk assessment for the project.

No external personnel may enter a containment laboratory for cleaning, servicing of equipment, repairs etc, unless a responsible member of staff has been informed and appropriate arrangements have been made for them to undertake their work safely.

References

General Articles, Reports, Workshops and Reviews that Include Environmental Benefits

An excellent detail on procedures of surveillance and emergency planning is described on the site https://www.hse.gov.uk.htm

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Report reviewing the evidence that Bt 176 corn pollen is toxic to Monarch larvae. Report concluded that on average, pollen counts on milkweed leaves were lower that those demonstrated to be toxic to larval neonates and that pollen counts only five meters from the field were close to zero. Most pollen falls within 5 meters of the field; more milkweed occurs in conservation areas compared to cultivated areas, excluding roadsides. Report concludes that data do not provide evidence that monarch larval stages and peak pollen shed in Ontario strongly overlap.

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Showed that a genotype with inferior seed production invaded natural habitats as successfully as did the wild genotype. This result can occur whenever population size is limited by factors other than seed production.

Siegel J P. 2001. The mammalian safety of Bacillus thuringiensis -based insecticides. Journal of Invertebrate Pathology **77**: 13-21.

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Stanley-Horn, DE, Dively, GP, Hellmich, RL, Mattila, HR, Sears, MK, Rose, R, Jesse LCH, Losey, JE, Obrycki, JJ, and Lewis, L. 2001. Assessing the impact of Cry1Ab-expressing corn pollen on monarch butterfly larvae in field studies. Proceedings of the National Academy of Sciences (USA) **98**: 11931-11936.

Study comparing Bt transgenic corn with isogenic corn found no significant differences in distribution, size and parasitism of egg masses of the European corn borer. Predator densities and parasitism of corn borer larvae did not differ between the two plots. The authors concluded that all observed differences in natural enemy population parameters under other study conditions were in the direction opposite to that expected if transgenic plants had an adverse impact.

Study in which Bt176 corn pollen and control corn pollen were fed to lady beetle larvae and survival of larvae was equivalent in both groups.

Study on the effect of Bt corn on aphids and their predators, green lacewings, showed no significant effect on aphid larvae development or lacewing mortality.

Study showed adverse effects of Bt corn pollen on Monarch larvae when pollen was present in very high quantities.

Study is a good example of out-crossing to relatives from conventional crops. Weedy rye most probably arose from hybridization between cultivated and wild plants. This study estimated genetic variation by isozyme analysis and multilocus out-crossing using the private-alleles method; results indicated little genetic differentiation had occurred among these 11 weedy rye populations whereas out-crossing was high.

Study showed multiple herbicide resistant canola volunteers as expected on the basis of the ability of canola to out-cross. Volunteers were easily controlled by alternative herbicides.

Sullivan DS and Sullivan TP. 2000. Non-target impacts of the herbicide glyphosate: A compendium of references and abstracts. 5th edition. Applied Mammal Research Institute, Summerland, British Columbia, Canada. 1-251.

Sun M and Corke H. 1992. Population genetics of colonizing success of weedy rye in northern California. Theoretical and Applied Genetics **83**: 321-329.

The authors measured transgene flow from transgenic oilseed rape to two wild species across 15,000 km2 in southeast England in populations where the wild plants were found. The following year new plants were screened for hybrid status. One hybrid was observed from the 505 plants screened in the B. rapa populations but none of the nine B. oleracea recruits were hybrids. Measures to minimize gene flow are suggested, and a procedure for the post-release evaluation and containment of GM cultivars is proposed.

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Chapter 5: The International Framework: WTO and IPRs

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Introduction

World Trade Organization (WTO) is a multilateral system outside the UN with mandate to develop, promote and oversee rule-based, fair and transparent global trade to help producers of goods and services, exporters, and importers for ushering in a more prosperous, peaceful and accountable economic world. Historically, WTO is the new international trade framework erected on the edifice of UN sponsored General Agreement on Tariff and Trade (GATT), which was founded in 1948 to oversee and promote trade in goods. The important differences between the WTO and the GATT are that the former comprehensively covers all aspects of trade, going beyond trade in goods, and binding of Members to all agreements governing the WTO. WTO was established under the Marrakesh Agreement concluded in 1994 on culmination of lengthy GATT trade negotiations held in Uruguay (called Uruguay Round) during 1986 to 1994 and came in to effect from 1 January 1995. GATT continues to be the principal rule-book for trade in goods under the WTO. The Uruguay Round also encompassed trade in services, trade related aspects of intellectual property, dispute settlement, and trade policy reviews.

Main principles of the trading system promoted by the WTO are non-discrimination, reciprocity, market access and fair competition. Non-discrimination is sought to be achieved by the 'most-favoured nation (MFN) status and national treatment to every Member country. MFN status provides all Member countries equal treatment in trade. For example, if a special favour such as a lower customs duty rate for one of the products is offered to an exporting Member by the importing Member, the latter has to extend similar treatment on the same product to all exporting WTO Members. There can, however, be exemption to this status arising from free trade agreements. National treatment means that a Member country market should treat locally-produced and imported goods, after the legal entry of latter through customs port, domestic and foreign services as well as intellectual property rights on equal terms. In other words national treatment means giving others the same treatment as one's own nationals. Reciprocity principle allows that favours or benefits such as concessional terms (include penalties) that are granted by one Member or its legal entities, are returned in kind. For example, low or zero tariff trade is allowed in regional, bilateral or pluri-lateral trade groupings such as the North American Free Trade Area (NAFTA), South American Free Trade Area (SAFTA), Asia-Pacific Economic Cooperation (APEC), South Asian Free Trade Area (SAFTA), Bangladesh, India, Myanmar, Sri Lanka and Thailand Economic Cooperation

(BIMSTEC), US-Singapore Free Trade Agreement, etc. Trade flow is usually hindered by several trade barriers. Lowering or removal of these barriers is one of aims of WTO to promote international trade. The more common barriers include customs duties (or tariffs) and measures such as import bans or quotas that selectively restrict quantity imported or high phytosanitary standards. Member countries are encouraged to "bind" their commitments to open their markets for goods or services. Market access is promoted through tariffication of non-tariff barriers and transparency in cross border trade. Thus the WTO trading system tries to improve predictability and stability in trade, promotes fair and competitive trade by minimizing or removing unfair trade distorting practices, such as export or farm subsidies, dumping, etc. Dumping means exporting products and services at cost below the actual production cost to gain market share.

WTO, started with 123 countries is currently participated by 153 Member and 30 observer countries. It oversees about 95 % of world trade of goods and services. All decisions are taken by the General Council (GC), which is represented by ambassadors or head of official delegations from each Member country. Decisions are invariably made on consensus by all Members. The Trade Policy Review Body and the Dispute Settlement Body are constituted by members nominated from the GC. The top level decision-making body of the WTO is Ministerial Conference (MC), which meets at least once in every two years.

Secretariat of WTO is in Geneva and headed by Director-General. The current annual budget of WTO is about 184.9 million Swiss Francs. Its functions include, administering WTO trade agreements; acting as forum for trade negotiations; deciding on trade disputes through dispute settlement mechanism; monitoring national trade policies; helping capacity building of developing countries through technical assistance and training; and cooperating with other international organizations to promote its goals. The WTO agreements are lengthy legal texts often complex, covering a wide range of activities. The complete set consists of about 30 agreements and separate commitments (called schedules) made by individual members in specific areas such as customs duty rates and services market-opening. The agreements deal with agriculture, textiles and clothing, banking, telecommunications, government purchases, industrial standards and product safety, food sanitation regulations, intellectual property, etc. The basic principles of WTO described above run throughout all of these agreements and constitute the foundation of this multilateral trading system. The developing and least developed countries and countries in economic transition are offered special and differential treatment special safeguard mechanisms in the application of most of the agreements. Broadly, these agreements may be clubbed under major WTO domains, such as trade in goods (GATT), trade in services (GATS), trade related aspects of intellectual property rights (TRIPS), trade related investment measures (TRIMS), dispute settlement mechanism (DSM), and trade policy review mechanism (TPRM).

Among the major agreements bound to the WTO, the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) is briefly discussed to understand the role of intellectual property in the trade.

Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)

Basic Principles

This agreement has 73 articles packed in seven parts. The first part containing general provisions and basic principles, comprising eight articles, set the overall principles of this agreement and the minimal level of legal protection Members are bound to provide on each of the eight kinds of intellectual property rights. These basic principles offer fair flexibility to Members in establishing and enforcing a *de minimus* intellectual property rights regime in their countries. TRIPS harmonises all earlier intellectual property conventions and treaties such as the Paris Convention, the Berne Convention, the Rome Convention, the Treaty on Intellectual Property in Respect of Integrated Circuits and to some extent the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure. The basic principles include national and MFN treatments, rights of priority and independence of patent. Rights of priority allows any inventor after making a first application on an invention in one Member country to make any number of applications in as many other Member countries on same invention within a specified period time and to gain the benefit of date of filing in all countries as has been done in the first filed country. This period is 12 months in case of patents and 6 months in the case of trademark. Independence of patent means that the fact that a patent has been granted for an invention in a given country does not exclusively constitute a ground for getting patent for the same invention in another country. The stated aim of the TRIPS agreement is promotion of technological innovation and the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge in a manner conducive to social and economic welfare, and to a balance of rights and obligations. While formulating or amending domestic laws and regulations in compliance with this Agreement, Members are allowed to use flexibility to adopt measures necessary to protect public health and nutrition, promote the public interest in sectors of vital importance to their socio-economic and technological development.

The Standards on different kinds of Intellectual Property Rights (IPRs)

The TRIPS agreement under part II, across articles 9 to 40, specifies the minimal standards and scopes to be enacted and enforced under eight kinds of IPRs. These IPRs are:

1. Copyright and Related Rights;
2. Trademarks;
3. Geographical Indications;

4. Industrial Designs;
5. Patents;
6. Layout-Designs (Topographies) of Integrated Circuits;
7. Protection of Undisclosed Information; and
8. Control of Anti-Competitive Practices in Contractual Licences.

Copyright and Related Rights

Copyright protection is brought in conformity with Berne Convention (1971). It offers exclusive ownership right to expressions and not to ideas. The protection is from unauthorized copying, translation, adaptation or sale of creative works such as literary, artistic or musical works, lectures, plays, art reproductions, models, photographic work, cinematographic works including films, sound recordings, broadcast, phonograms, any other work of applied art, computer programmes, compiled data (machine readable or other forms), etc. A copy right is automatically established when ever a work of this nature is created or performed. The right accrued is global. However, registration of a copy right is important for asserting the legal right during action against infringements. The mandated duration of protection of a work, other than a photographic work or a work of applied art, shall be no less than 50 years from the end of the calendar year of authorized publication over and above the life span of the person who created the work. In case the work is not published within 50 years from the making of the work, 50 years from the end of the calendar year of making is the period of protection. The term of the protection to performers and producers of phonograms shall be a minimum of 50 years computed from the end of the calendar year in which the fixation was made or the performance took place. Where Members grant rights to broadcasting organizations, the term of protection shall be a minimum of 20 years from the end of the calendar year in which the broadcast took place.

Trademarks

Any sign, or any combination of signs, words including personal names, letters, numerals, figurative elements and combinations of colours as well as any combination of such signs, which are visually perceptible and capable of distinguishing the goods or services of one undertaking from those of other undertakings, shall be eligible for registration as trademarks. The duration of protection of a trademark after initial registration, and after every renewal of registration shall be for a minimum term of seven years. The renewal of a trademark shall be indefinite.

An application for trade mark shall not be refused solely on the ground that intended use has not taken place before the expiry of a period of three years from the date of application or the nature of the goods or services to which the trademark is intended. The owner of a registered trademark shall have the exclusive right to prevent all third parties not having the owner’s consent from using in the course of trade identical or similar signs for goods or

services which are identical or similar to those in respect of which the trademark is registered where such use would result in a likelihood of confusion.

Normally continuous disuse of a trademark, without valid reason, exceeding three years may qualify for cancellation of its registration. Trademarks could be licensed or assigned with or without con-joined business.

Geographical Indications

Geographical indications identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin.

Unlike other types of IPRs, GI is a collective mark owned by all concerned within an indicated region and not exclusively exercised either by single individual or firm. Examples are Champagne, Scotch whisky, Basmati rice, Florida Oranges, Darjeeling tea, Prosciutto di Parma, New Zealand Lamb, Malabar black pepper, Feta cheese, Czech crystal, Swiss watches, Indian carpets and many more.

GIs have long been common in Europe, where there is a tradition of associating certain food products with particular regions. The Lisbon Agreement, 1958 provided elaborate provision on the protection of Appellations of Origin (AO) and their registration. An AO is a special kind of GI used on products that have a specific quality that is exclusively or essentially due to the geographical environment in which the products are produced. The concept of GI is inclusive of AO. Some, however, view that what is considered a very specific term for a well-known local specialty in one country may constitute a generic term or genericized trademark for that 'type of' product in another. For example, 'Parmigiano' cheese in Italy is generically known as *Parmesan* cheese in Australia and the United States.

TRIPS take into account these variations and require that Member countries interested to protect their GI have to provide the legal mean to prevent misuse of geographical name in a manner to mislead the public ('passing off'). It specify that Members in their national legislation could refuse or invalidate the registration of a trademark which contains a GI with respect to goods not originating in the indicated territory, if use of such indication in the trademark for such goods in their country could mislead the public as to the true place of origin of the goods concerned. However, TRIPS offers no obligation to protect GIs which are not or cease to be protected in their country of origin, or have fallen into disuse. In other words protection under GI should start from the country of origin supported by appropriate legislation.

Where a trademark has been applied for or registered in good faith, or where rights to a trademark have been acquired through use in good faith either before the date of these provisions taking effect in a Member country; or before the GI is protected in its country of origin; measures adopted to implement the GI shall not prejudice eligibility for or the validity of the registration of a trademark, or the right to use a trademark, on the basis that such a

trademark is identical with, or similar to a GI. TRIPS also safeguards the right of any person to use, in the course of trade, that person's name or the name of that person's predecessor in business, except where such name is used in such a manner as to mislead the public.

Members have the right to enter into negotiations for expanding the protection of individual geographical indications and other Members shall cooperate to conduct such negotiations or to conclude bilateral or multilateral agreements. The Council for TRIPS at the request of a Member, shall consult with any Member or Members to facilitate negotiations and to address matters affecting the compliance with the obligations under the provisions of GI.

TRIPS offer special protection to the GI of wines. Accordingly, every Member is required to provide the legal means to prevent 'passing off' for wines not originating in the place indicated by the GI in question or the GI is used in translation or accompanied by expressions such as "kind", "type", "style", "imitation" or the like. It also requires refusal or invalidation of registration of a trademark for wines which contains or consists of a GI identifying wines or for spirits which contains or consists of a GI identifying spirits. In the case of homonymous GIs for wines, protection shall be accorded to each indication, after determining the practical conditions under which the homonymous indications in question is distinguishable from each other, subject that such determinations receive equitable treatment of the producers and that consumers are not misled.

Industrial Design

Industrial design (ID) is the product of professional process of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer. It involves a shape, configuration, pattern, ornament, composition of lines or colours applied to any article in a manner to provide a visual appeal and judgement. The role of an industrial design is to provide design solutions towards problems of form, usability, user ergonomics, engineering, marketing, brand development and sales. TRIPS require Members to provide for the protection of independently created industrial designs that are new or original, but not to those which are not new or original and do not significantly differ from known designs or combinations of known design features. However, such protection should not extend to designs dictated essentially by technical or functional considerations. ID may occasionally overlap with copyright. For example, the textile designs may be protected through either industrial design law or copyright law. Like other IP forms, ID offers the owner of a protected industrial design to have exclusive right to prevent third parties from making, selling or importing articles bearing or embodying a design which is a copy, or substantially a copy, of the protected design, without owner's consent when such acts are undertaken for commercial purposes. The minimum period of protection stipulated is 10 years. This can be subsequently extended for equivalent period.

Patent

An important aspect of TRIPS is that it provides for patent for any invention, whether products or processes, in all fields of technology, provided that they are eligible otherwise (Art.27). The three major eligibility criteria to receive patent for an invention are novelty, non-obviousness or involving an inventive step and utility or amenability for industrial application. Further, patents shall be available and patent rights enjoyable without discrimination as to the place of invention, the field of technology and whether products are imported or locally produced.

TRIPS agreement offer three exemptions to its affirmation that patents shall be available for any invention, whether products or processes, in all fields of technology. These are:

1. Members may exclude from patentability inventions, the prevention within their territory of the commercial exploitation of which is necessary to protect *ordre public* or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment, provided that such exclusion is not made merely because the exploitation is prohibited by their law (Art. 27.2);
2. Members may also exclude from patentability diagnostic, therapeutic and surgical methods for the treatment of humans or animals (Art. 27.3 a);
3. Members may also exclude from patentability plants and animals *other than micro-organisms*, and essentially biological processes for the production of plants or animals *other than non-biological and microbiological processes*. However, Members shall provide for the *protection of plant varieties either by patents or by an effective sui generis system or by any combination thereof (Art. 27.3b).*

Patent is a legal grant conferring exclusive rights to the patent owner. This right excludes third parties not having the owner's consent, in the case of a product, from the acts of making, using, offering for sale, selling, or importing that product for these purposes; and in the case of a process, from the act of using the process, and from the acts of using, offering for sale, selling, or importing for these purposes the product obtained directly by that process. The patentee, however, shall have the right to assign, or transfer by succession, the patent and to conclude licensing contracts.

One important condition for the grant of patent is disclosure of the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art. It may also require the applicant to indicate the best mode for carrying out the invention known to the inventor at the priority date of the application. A patent grant is applicable within the geographic territory of the country of grant for a period not less than 20 years from the date of filing of application.

Art. 27.3.(b) is important from the point of view of biotechnology research. It requires all Members to grant patent to qualified inventions related to microorganisms, microbiological and non-biological processes. Novel biotechnology process is also eligible for patenting.

When the product patent principle is applied on a product derived from a novel biotechnology process, such product may or may not be patentable subject to the policy of the Member on the patentability of plants and animals. Apart from biotechnology, the product and process patent have implications to innovations in chemical, pharma, biochemical and food processing areas. While a process patent largely specifies to a chemical/biochemical pathway or an operational or production process leading to the product, a product patent allows enhanced monopoly to the inventor on larger technological domain to exclude others from developing alternate novel pathways or processes to produce the same or equivalent product.

It is important to appreciate that a patent established in one country is of no concern in another where it is not established. In fact, there is no international patent, unless a patent is established in all countries according to their independent laws. Extension of a patent from the first country of application to other countries has to be completed within 12 months. (The Patent Cooperation Treaty-PCT- administered by the World Intellectual Property Organisation facilitates patenting in multiple countries at lower cost and lesser time). Grant of patent to a given invention by a country shall be subject to independence of patent. A patent may automatically lapse after the specified period of protection or earlier when it is abandoned by the patentee.

Notwithstanding a Member's policy on granting or not granting patent to plants and animals, TRIPS make protection of plant variety either by patents or by an effective *sui generis* system or by any combination of these two mandatory. *Sui generis* is a very special kind of IP protection having major difference from patent. Latin words *sui generis* mean 'self generated' or 'unique by itself'. One familiar *sui generis* system used for protection of plant varieties is the plant breeder's right (PBR) in the International Union for the Protection of New Varieties of Plants (UPOV). PBR is a right granted to the breeder to exclude third parties from producing, selling, marketing, distributing, importing or exporting the propagating material of the protected variety. This right, like in the case of patent, is assignable or transferable by succession or licensable. It is important to note that the term *sui generis* system in TRIPS does not essentially imply to the UPOV and Members have flexibility to evolve their own effective *sui generis* system. PBR, unlike patent, is not an absolute right; it is inclusive of farmers' rights (so called farmers' privilege in UPOV) and researchers' rights (what UPOV allows as acts done for experimental purposes including breeding new varieties). The FAO Seed Treaty (the International Treaty on Plant Genetic resources for Food and Agriculture) defines farmers' rights as the right to save, use, exchange and sell farm-saved seed/ propagating material of varieties including protected varieties; right for the protection of traditional knowledge relevant to PGRs and to equitably participate in sharing benefits arising from the utilisation of PGRs; and right to participate in making decisions on matters related to conservation and sustainable use of PGRs.

A patent is liable for compulsory licensing under certain extra-ordinary situation. TRIPS stipulate that such licensing should be done only with authorization of the right holder (Art.

31). Members have the right to exercise TRIPS flexibilities in the healthcare sector to protect public health by facilitating affordable access to medicine in poor economies, particularly during public health emergencies (pandemic) by resorting to compulsory licenses in case the patentee is failing to meet the national requirements either in terms of volume of production or in reasonable cost. Under the compulsory license, the exclusive right granted to the patentee is temporarily suspended to allow third parties to work the patent or its generic equivalents for a determined period.

An important provision in TRIPS in respect of civil proceedings arising from suspected infringement of the rights of the owner of a process patent for obtaining a product is that the judicial authorities are empowered to order the defendant to prove that the process to obtain an identical product is different from the patented process. Here the burden of proof on an impugned infringement lies with the defendant. The legal procedure, however, safeguard the legitimate interests of defendants in protecting their manufacturing and business secrets in case the alleged infringement proves to the contrary.

Layout Designs (Topographies) of Integrated Circuits

Topography of an integrated circuit is a spatial geometric arrangement, fixed on a material carrier, of all the components of an integrated circuit and the connections there between. Integrated circuit is a microelectronic product, designed to carry out the function of the electronic circuit.

TRIPS deem that importing, selling, or otherwise distributing for commercial purposes a protected layout-design, an integrated circuit in which a protected layout-design is incorporated, or an article incorporating such an integrated circuit without the authorization of the right holder as unlawful. Member countries are required enforce domestic law to make such act unlawful and to provide prompt legal relief to the right holder including a sum equivalent to a reasonable royalty such as would be payable under a freely negotiated license in respect of such a layout-design. It also lays out conditions and compensations on non-voluntary licensing. The term of protection of layout-designs shall be at least a period of 10 years counted from the date of filing an application for registration or from the first commercial exploitation wherever is earlier.

Protection of Undisclosed Information

Although undisclosed information has often been referred to as “trade secrets” or “know-how”, TRIPS do not use these terms. It also does it provide a definition of “undisclosed information”. Such a neutral terminology does not characterize the contents of the information, but only its “undisclosed” nature. “Undisclosed information” covers any secret information of commercial value, including technical know-how, such as design, process, formula and other technological knowledge often resulting from experience and intellectual ability; data of commercial value, such as marketing plans, customers lists and other business-

related information that provides an advantage over competitors; and test and other data submitted for the approval of pharmaceutical and chemical products for agriculture. The obligation established is limited to the protection of undisclosed information "against unfair competition as provided in Article 10*bis* of the Paris Convention".

The unfair competition provides a remedy against acts of competition contrary to honest business practices, such as confusing or misleading the customer and discrediting the competitor. An act of unfair competition may be defined as "any act that a competitor or another market participant undertakes with the intention of directly exploiting another person's industrial or commercial achievement for his own business purposes without substantially departing from the original achievement." TRIPS stipulate that an "undisclosed information" may be qualified for protection if it is secret, possess a commercial value and be subject to reasonable steps, under the circumstances, to be kept secret. Members shall protect such data against disclosure, except where necessary to protect the public, or unless steps are taken to ensure that the data are protected against unfair commercial use. The undisclosed information shall remain so as long it is protected by the owner, the legal system of the Member and not deciphered by honest practice by a third party.

Control of Anti-Competitive Practices in Contractual Licenses

One of the important objectives of IPRs is promotion of innovations in technology development, its dissemination to promote competition and public benefit with economic growth and better quality of life. Licensing is a common method in the transfer of IP protected technologies. Therefore those practices, which restrain competition may have adverse effects on trade, transfer and dissemination of technology and public welfare. TRIPS, therefore, allows Members to devise suitable legislative measures to prevent misuse of IPRs to advance monopoly and to prevent competition in a Member's market.

In the event of the IPR owner is a national or domiciliary of one Member and this entity while working of that IPR in another Member country is violating the laws and regulations of the latter, solution to such problems through consultations and cooperation between them are stipulated. Such cooperation may involve supply of publicly available and relevant non-confidential information to the matter in question and of other information available to the Member, subject to domestic law and to the conclusion of mutually satisfactory agreements concerning the safeguarding of its confidentiality by the requesting Member. In the event of nationals or domiciliaries of a Member are subject to proceedings in another Member on alleged violation of the latter Member's laws and regulations, an opportunity for consultations by the other Member, upon request, is to be allowed.

General Obligations

Members, apart from establishing a TRIPS compliant legislative framework for providing a *de minimus* protection to all types of IPRs covered by this Agreement, are required to

establish an administrative and jurisprudential system efficient and effective in enforcement of the IPR laws and regulations. Such system has to permit effective action against any act of infringement of IPRs and expeditious remediation to prevent infringements and deterrent penal action. These procedures, which shall be fair and equitable, are to be applied in such a manner not to create barriers to legitimate trade and to provide for safeguards against their abuse. Also important is that the administrative and judicial process shall not be unnecessarily complicated or costly, or entail unreasonable time-limits or unwarranted delays. Decisions on the merits of a case shall be evidence-based with fair opportunity for the parties to be heard. There should be appellate judicial authority to review the final administrative decisions, subject to jurisdictional provisions in a Member's law concerning the importance of a case. It, however, does not imply that there is any obligation to put in place a judicial system for the enforcement of IPRs distinct from that for the enforcement of law in general.

Transitional arrangements

The transitional period provided to developing countries to bring their IPR regime in compliance with TRIPS, including the product patent, expired on 31 December 2004.

In the case of the least-developed country Members, the time line to bring their domestic laws in compliance with TRIPS in respect of all IPRs embraced by this Agreement was extended just before Hong Kong Ministerial from 1 January 2006 to 1 July 2013. The transition period for these countries for product patents is until 2016. However, all countries, with effect from January 1995 are required to comply with the general principles on Most-Favoured-Nation Treatment, National Treatment and Multilateral Agreements on acquisition or maintenance of protection.

During the transition period and later, the developed country Members are required to provide incentives to enterprises and institutions in their territories for promoting and encouraging technology transfer to least-developed countries to enable them to create a sound and viable technological base.

Dispute Prevention and Settlement

For preventing disputes, Members shall maintain transparency and access to information on the laws and regulations, and final judicial decisions and administrative rulings of general application and those pertaining to availability, scope, acquisition, enforcement and prevention of the abuse of intellectual property rights. This information is either published, or made publicly available in a national language, in such a manner as to enable governments and right holders to become acquainted with them. Any Agreement on the matter which is in force between the governmental agencies of a given Member and others shall also be published. These are also shared with the Council for TRIPS. Such information sharing, however, shall not disclose confidential information which would impede law enforcement or

otherwise be contrary to the public interest or would prejudice the legitimate commercial interests of particular enterprises.

On receipt of a compliant from a Member related to the IPR issues pertaining to another, the Council of TRIPS may examine the scope and modalities for complaints within the stipulated time period and submit its recommendations to the Ministerial Conference for approval. Any decision of the Ministerial Conference to approve such recommendations or to extend the period of decision shall be made by consensus. The approved recommendations shall be effective for all Members without further formal acceptance.

Institutional Arrangements

The Agreement assigns the mandate to monitor its operation, particularly the compliance of Members with their obligations to the Council for TRIPS. It is also obliged for providing any assistance requested by Members in the context of dispute settlement procedures. The Council for TRIPS is required to review the implementation of this Agreement after the expiration of the transitional period. In addition, the Doha Ministerial entrusted the Council for TRIPS a work programme to review of Article 27.3(b), review of the implementation of the TRIPS Agreement and to examine, *inter alia*, the relationship between the TRIPS Agreement and the Convention on Biological Diversity, the protection of traditional knowledge and folklore.

The international framework: The International Treaty on Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture[1] (IT or ITPGRFA) was adopted on 3 November 2001 under the auspices of the Food and Agriculture Organisation (FAO). As evident from its title, this Treaty relates to plant genetic resources for food and agriculture (PGRFA). The Treaty defines PGRFA as *any genetic material of plant origin of actual or potential value for food and agriculture* [Article 2].

Background of the Treaty

The Treaty had its origin to the historic role FAO had been playing since 1983 with the establishment of the International Undertaking on Plant Genetic Resources (IUPGR) and setting up an independent Commission on Plant Genetic Resources (CPGR)[2]. The Agenda 21 in 1992 called for strengthening the FAO Global System on PGR and its harmonisation in line with the Convention on Biological Diversity (CBD)[3]. The CBD heralded a paradigm change in the global perspective on the PGR from that of "a heritage of humankind" to that with "state exercising sovereign rights over". The CBD adopted in the Nairobi Final Act in May 1992 reaffirmed the sovereign rights of states over their own biological resources. This rights, however, are limited *to the components of biological diversity, in areas within the limits of its*

national jurisdiction (Art. 4), meaning that the said sovereignty did not extend on those PGR which were collected from many States and being kept in *ex situ* gene banks outside their national jurisdiction prior to the adoption of CBD. These PGR were largely constituted by those seed accessions, numbering over 7,00,000, being conserved in 11 International Agricultural Research Centres (IARCs) under the Consultative Group on International Agricultural Research (CGIAR). More than 70% of these accessions comprising landraces and wild materials were collected from farmers and indigenous peoples in the developing countries. Having the rights on these PGRs left outside the scope of CBD, the Nairobi Final Act adopted Resolution 3, with directions to seek solutions to outstanding matters concerning PGR[4].

According to this Resolution the FAO entered into an Agreement with the CGIAR in October 1994 on the PGR collections conserved in IARCs as an interim arrangement. This Agreement placed these PGRs under the politico-legal protection called "trusteeship" of the Commission on Genetic Resources for Food and Agriculture (CGFRA), which is an intergovernmental authority evolved from the CPGR. It was further agreed that: (1) the designated germplasm shall be held "in trust" by the IARCs for the benefit of humanity; (2) this 'in-trust germplasm' shall be maintained properly and shared freely for the purpose of conservation, research and plant breeding only through a model MTA; and (3) none shall be allowed to take out IPR on the "in-trust germplasm in the form received", including third party IPR claims.

Another outstanding issue referred to in the Resolution 3 was the question of Farmer's Rights. The Farmers' Rights (FR) as a concept was brought forth and recognized by the IUPGR of the FAO in 1983. In 1989 FAO recognized the plant breeders' rights (PBR) introduced by the UPOV[5] in 1961 and the FR. According to the IUPGR, FR is "the rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources, particularly those in the centers of origin or diversity". These rights are vested with the international community, as the trustees for the present and future generations of farmers, for the purpose of ensuring full benefits to the farmers and supporting continuation of their contributions. Farmers' Rights gained wide socio-political significance in the context of emergence of private seed companies and globalization of PBR by the TRIPS in developing countries where seed system and diversity are strongly associated with farmers' varieties. Crop genetic resources in landraces and farmer varieties share several characteristics with intellectual goods that are protected as intellectual property[6]. However, FR lacked legal sanctity and left excluded in international conventions or agreements like CBD or TRIPS, while PBR gained wider legal status under the *sui generis* system of plant variety protection. Hence the reference to FR in Resolution 3 was a reminder of the unfinished agenda on FR.

Pursuing the Resolution 3, the FAO initiated negotiations at the CGRFA level in November 1994 with following three important mandates: (1) the harmonization of the

IUPGR with the CBD; (2) to decide on the issue of access on mutually agreed terms to PGR, including *ex situ* collections not addressed by the CBD; and (3) the issue of the realization of FR.

The major elements of harmonization between IUPGR and CBD are the paradigm change brought by the CBD conferring "sovereignty of national governments over their PGR" and the facilitated process of access to the PGR through prior informed consent (PIC), mutually agreed terms (MAT), material transfer agreement (MTA), and fair and equitable sharing for the commercial use of these resources. Access on PGR within the national jurisdiction of Members as well as to those deposited in the *ex situ* collections, but not addressed by the CBD was an important negotiation issue. The third issue was on realization of FR to promote the contributions of farmers all over the world, particularly those in centres of origin and diversity, in conserving, improving and making available these resources for the future food and agriculture. On July 2001, the Sixth Session of CGFRA adopted revised IU. On November 2001, the International Treaty was adopted by the FAO Conference and it marked the culmination of a slow and arduous process over seven years. It entered into force on 29 June 2004. As on August 2008, 120 countries have joined as Parties to the Treaty.

Rationale of the Treaty

PGRFA are crucial in feeding the world, human and livestock. It include the land races which farmers have selected and conserved, other varieties and the wild relatives of crop plants. They constitute the raw material of huge value for improving the quality and productivity of all crops through modern plant breeding. The genetic variability of each and every crop is not uniformly distributed in the world. Different regions and countries situated within each region are endowed with variable wealth of PGR in different crops. No single country in the world, however rich it might be for its PGRFA, is self-sufficient in this respect for ensuring its food and feed security, now and in future. This diversity stands as a testimony to the profound contribution made by the farmers world over. They are not only generating a huge genetic variability and conserving them, but also building equally rich traditional knowledge on every component of this variability including the wild relatives. The flow of genetic variability for crop improvement is primarily from the PGR rich regions. Continuous genetic improvement is cardinal for sustaining regional and global food security under increasing population, need for continuous increase in productivity and quality in some cases, mitigating biotic and abiotic pressures including the new challenges from the climate change. Hence, there is an inevitable dependence across countries to sustain agricultural production and global food security. Therefore, collective agricultural future of global community demands a framework for international cooperation in supporting farmers for conservation of PGR and exchange of these resources and their genes. This Treaty devised with this rationale in the CBD context.

The Framework of the Treaty

The Treaty is structured with a Preamble, the text, and two annexure[1]. The text has 35 Articles tucked under seven titles, Introduction; General Provisions; Farmers' Rights; The Multilateral System of Access and Benefit Sharing; Supporting Components; Financial Provisions; and Institutional Provisions. The Annexure I provide the list of crops covered under this Treaty, and Annexure II has Arbitration and Conciliation in two parts. The Treaty is to be administered by a Governing Body (GB) represented by all Contracting Parties (CPs) with equal voting right and decisions taken on consensus.

In the Preamble, the CPs acknowledges the importance of conservation, exploration, collection, characterization, evaluation and documentation of PGRFA for removing contemporary global poverty and ensuring food security of future generations and the need for reinforcing the capacity of developing countries to undertake such tasks in perpetuity. The CPs affirms that the farmers, world over and particularly in the regions of primary and secondary centers of genetic diversity of all crop plants, had been, are and will be playing invaluable role in conserving, improving and making available plant genetic resources and this entitles them for the Farmers' Rights (FRs). This Treaty is the first legally binding international agreement, which has defined the FRs.

Objectives and Scope of the Treaty

The primary objective is to achieve sustainable global agriculture and food security in harmony with CBD by (1) conservation and sustainable use of PGRFA, (2) facilitation of fair and equitable sharing of benefits derived from the commercial use of PGR, and (3) establishment and maintenance of a multilateral system for access to PGRFA and benefit sharing, thereof. The scope of the Treaty is the *in situ* and *ex situ* PGRFA of the crop species listed therein (Art 1).

Treaty mandates

Treaty encourages CPs to establish domestic legislations in conformity with the laws, regulations and procedures spelt out therein. The Treaty mandates that the CPs shall mutually cooperate to promote an integrated approach to explore, conserve and sustainably use PGRFA. This may include survey and inventory of PGRFA, collection of information associated with these genetic resources, their potential use and threat of potential loss, promoting and supporting farmers and local communities to undertake *in situ* conservation of these resources, including wild crop relatives, establishing protected areas of PGRFA by involving indigenous and local communities, promoting *ex situ* conservation along with documentation, characterization, regeneration and evaluation while keeping genetic integrity of collections.

On sustainable use of PGRFA, the Treaty requires the CPs to promote development and maintenance of diverse farming systems, which will support more biological diversity and other natural resources, strengthening research including plant breeding with participation of farmers to promote development of varieties adapted to social economic, ecological and marginal farming conditions, to enhance intra- and inter-specific variation in crops to reduce genetic vulnerability and to prevent genetic erosion, and to encourage increased use of local and locally adapted varieties of crops including underutilized crops.

The Treaty offers international cooperation to establish and strengthen the capabilities of developing countries and countries in economic transition in conservation and sustainable use of PGRFA, strengthening institutional arrangements under Global Plan of Action (GPA), to promote access to and sharing of PGRFA, and to support the CPs in these efforts with funding and technical assistance.

Farmers' Rights

Farmers' Rights find an important place in the Treaty with definition of rights intended thereto. Apart from emphatically declaring the rights of farmers to save, use, exchange and sell farm saved seed and other propagating material, the Treaty adds three more important rights to farmers. These are: (1) the right on the traditional knowledge relevant to the PGRFA, (2) the right to participate in decision making at national level on matters related to conservation and sustainable use of PGRFA, and (3) the right to equitably participate in sharing the benefits arising from utilization of PGRFA. While the Treaty acknowledges that these rights are important to promote the invaluable contributions being made by farmers in the conservation and development of plant genetic resources, it relegates the responsibility of realizing FR to the concerned governments.

Multilateral System of Access and Benefit Sharing

The multilateral system (MLS) provided is the major Treaty instrument and it has three essential aspects: (1) The coverage of PGRFA brought under the MLS (Table 1); (2) The facilitated access provided for this PGRFA; and (3) The system of benefit sharing available to the providers of PGRFA. The MLS is established in conformity with the CBD principles on the sovereignty of states over their PGRFA and their sovereign authority to decide on access to these resources. The Treaty legally binds CPs to place the agreed components of PGRFA under the MLS for facilitated access by other Parties and sharing of the entitled fair and equitable benefits. The PGRFA brought under MLS are listed in Table 1 and these PGRFA are located both under the jurisdiction of the CPs and in the public domain including in the *ex situ* gene banks of IARCs.

The MLS, within the jurisdiction of each CP, seeks to reach out to all PGRFA being held by natural and legal persons, including the public and private sectors, farming and local

communities. The Governing Body is required to review the access to the PGRFA and to decide appropriate measures to achieve this coverage. Out of the 666,000 and odd collections available in the IARC gene banks, only about 532,000 are brought under the MLS of this Treaty and remaining collections belonging to species not listed in Table 1 are left out from MLS. These accessions, according to the Treaty, shall be held in "trusteeship" by the CGIAR and be made available according to the 1994 FAO-CGIAR Agreement. The Treaty further undertakes to make efforts to bring these accessions under the MLS within an indicated timeframe.

Table 1. Crop groups and species brought under the MLS of the FAO Treaty

Crop Group	No. of Crops	PGRFA belonging to
Cereals	10	Rice, Wheat, Maize, Sorghum, Pearl millet, Finger millet, Barley, Oat, Rye, Triticale
Pulses	7	Chick pea, Pigeon pea, Pea, Cowpea, Faba bean, Lentil, Lathyrus
Tubers	5	Potato, Cassava, Sweet potato, Yams, Major aroids*
Oil Crops	3	Sun flower, Brassica complex**, Coconut
Sugar Crops	1	Beet
Fruit crops	5	Banana, Apple, Strawberry, Citrus, Breadfruit
Vegetables	4	Egg plant, Beans, Carrot, Asparagus, (Cabbage, Radish, Turnip)**
Food Crops-Total	**35**	
Legume forages	52 Species	Belonging to 15 genera
Grass forages	26 Species	Belonging to 12 genera
Other forages	3 species	Belonging to 2 genera
* Aroids include four species ** Brassica complex includes few oilseed and vegetable species belonging to 13 listed genera		

The Treaty establishes legal supervision of GB over concerned CGIAR institutions for the purpose of providing policy guidance relating to *ex situ* collections held by them. The GB shall also periodically monitor the access and use of PGRFA from the IARC gene banks, provide for management and administration of these *ex situ* collections in accordance with the internationally accepted scientific and technical standards under the authority of CGIAR. GB is also vested with authority to evacuate and transfer these collections from any IARC, with the approval of host country, in case the maintenance of these collections are impeded or threatened by whatever event.

Access to MLS

Facilitated access through MLS is provided to CPs and the legal and natural persons under their jurisdiction. Legal and natural persons include private and public sectors, farming

and indigenous communities. Access to PGRFA is, however, allowed only for the purpose of use and conservation for research, breeding and training for food and agriculture and not for uses in chemical, pharmaceutical and other non-food or feed industries. Access is to be allowed expeditiously, either free of charge or at a minimal charge. Subject to the national law on the subject, the access to genetic resource may include all available passport data and descriptive information on the accessed material. Access to those PGRFA under development shall be allowed at the discretion of the developer, farmer breeder or professional breeder. The Treaty for the purpose of access discriminates the *ex situ* and *in situ* PGRFA and requires that access to *in situ* material shall be governed by the relevant national legislation or as advised by GB, wherever no national legislation exists. In the case of *ex situ* collections in IARCs, the Treaty requires that each accession has to be identified for its geographic origin and countries have to be allowed access with out MTA to those accessions originated from their jurisdiction.

Another important access requirement is that the Party accessing shall not establish any intellectual property right or such other rights on the PGRFA or its genetic parts of components, in the form received from the MLS and that the accessed material or its products shall be placed in the MLS for continued access by other Parties. Access to PGRFA protected by IPR shall be consistent with the international law applicable thereof. A CP having subjected to a disaster shall have access to appropriate PGRFA through MLS to re-establish the agricultural system lost or damaged in a disaster. Access, according to the Treaty, shall be facilitated through a standard material transfer agreement (SMTA), which was approved by the GB in its Resolution 1/2006 of 16 June 2006. The SMTA is consistent with the relevant provisions of this Treaty. On the obligations of a recipient who may conserve an accessed material, the SMTA requires that the material and the related information shall be made available to the Multilateral System using the SMTA and in case the recipient transfers the material supplied under this Agreement to another person or entity, such transfer shall be only under the terms and conditions of the SMTA, through a new MTA and under notification to the GB. The SMTA has specific provisions on fair and equitable sharing of benefit arising from the commercialization of product that is a PGR**.**

Benefit Sharing under MLS

The Treaty suggests monetary and non-monetary kinds of benefit sharing[7]. The non-monetary benefits include exchange of information, access and transfer of technology, and capacity building. A fixed percentage of monetary benefit sharing is binding on a recipient who commercializes a product that is a PGRFA and that incorporates material accessed through the SMTA and where such product is not available without restriction to others for further research and breeding. In case the commercialization of such product is done in a manner so that it is available to others without restriction for further research and breeding, the recipient is encouraged to make voluntary payments towards benefit sharing. The recipient

is encouraged to share through the MLS non-monetary benefits such as non-confidential information that results from R&D carried out on the Material. Those who obtains IPR on any products developed from the material or its components, obtained from the MLS, and assigns such IPR to a third party, the benefit-sharing obligations thereto shall also be transferred to such third party. The small farmers in developing countries are exempted from paying the benefit share in case they commercialize any PGR accessed from MLS.

The non-monetary benefit sharing like information, may include catalogues and inventories on PGRFA, information on technologies, technical, scientific and socio-economic research outputs including characterization, evaluation and utilization data. The technologies may include techniques for conservation, characterization, evaluation and use of PGRFA, improved varieties bred from accessed PGRFA in conformity with applicable IPR and access laws. The Treaty provides scope for transfer of these technologies under different patterns, depending on the technology absorption capability and the relevant domestic legal framework of the recipient Party. Treaty provides that technology transfer for the benefit of farmers in developing and least developed countries shall be on most favoured terms, including concessional and preferential terms, *albeit* upholding the involved IPRs.

Capacity building is to benefit developing and least developed countries lacking scientific and technical capability in conservation and sustainable use of PGRFA. This may include need-based development of infra-structure and human resource for conservation and sustainable use of PGRFA, and building institutionalized scientific research capability to accrue benefit to the national agriculture.

Treaty is to engage public and private sectors for sharing monetary benefit. The GB is to determine the quantum, form and manner of payment of monetary benefit consistent with the commercial scope, on case-to-case basis. The GB is also responsible to review the process of determining benefit share from time to time to improve fairness and equity. CPs are also encouraged to institute voluntary benefit sharing contributions from food processing industries, because they are beneficiaries of the PGRFA. All monetary payments received, as mandatory or voluntary benefit share will flow to the fund called Global Crop Diversity Trust. These receipts are to be utilized for the agreed activities on conservation and sustainable use of PGRFA by farmers of the CPs, particularly of the developing countries.

Global Plan of Action

The Treaty is essentially a legal framework to implement the global plan of action (GPA)[8] for the conservation and sustainable use of PGRFA detailed in the 1996 Leipzig Declaration. The Treaty provides a forum for the CPs to join hands to undertake national actions assisted by international cooperation. Towards this, the Treaty provides for establishing International Plant Genetic Resources Networks (IPGRN) and a Global Information System (GIS) on PGRFA. The IPGRN is to achieve as complete coverage as possible of PGRFA and relevant institutions dotting across the CPs. The GIS shall cover

scientific, technical and environmental aspects related to PGRFA, with a view to benefit all CPs, to monitor conservation and sustainable use of PGRFA, to serve early warning on the emerging threat to PGRFA, and to generate periodic assessment on the state of the global PGRFA.

Implementation of the Treaty

Each CP is obliged to implement the Treaty within its technical and financial capability. Since all the PGRFA covered by this Treaty are located in the jurisdiction of CPs, particularly the developing countries and the eleven IARCs, their natural or empowered capability will largely determine the effectiveness of the Treaty implementation. The GB shall be chaired by elected Chairperson and Vice-Chairpersons and it shall provide policy directions, approval to plans, programmes and budgets, recommendations, monitoring and do such other functions required for promoting international cooperation, administration of *ex situ* collections in the CGIAR institutions, strengthening financial base, amending the treaty (only with consensus), etc. A regular biennial session of GB is mandatory with scope for as many special sessions as required or requested by at least one-third of the CPs. The day-to-day administration, on behalf of the GB, shall be conducted by the Executive Secretary to the GB, who shall be appointed by the Director General of FAO with the approval of the GB.

Finance for Implementation of Treaty

This Treaty is born with no institutional financial back up. Hence, it seeks to establish an endowment Trust Fund of US $ 260 m with a view to secure an annual yield of interest in perpetuity for its global administration. This fund is to be mobilized from public and private sectors, including national governments, international institutions, non-governmental foundations and a diverse array of industrial sectors. When this Treaty came into force on 29th June 2004, US $ 45 m has been committed and commitment for another US $ 60 m was in progress. Apart from this fund, the GPA on PGRFA has to be supplemented by each CP within their national technical and financial resources. Financial support also needs to flow for the *ex situ* conservation in IARCs and to support special assistance to implement agreed plan and programmes for farmers in developing countries. The GB shall be periodically setting a target for such funding. The monetary benefit share flowing to the CP from Trust Fund shall also be deemed as the funding under the Treaty.

Dispute Settlement Mechanism

Treaty provides mechanism for settlement of disputes arising among the CPs either through mutual negotiation or third party mediation. There are also defined procedures for arbitration and reconciliation.

The international framework: CBD and the Cartagena Protocol on Biosafety

The Cartagena Protocol on Biosafety (CPB) is the first international agreement to regulate the transboundary movements of living modified organisms (LMOs). The CPB is a subsidiary agreement to the UN Convention on Biological Diversity (CBD), which was signed by 191 governments since its conclusion at the Rio Earth Summit in 1992.

Conceived as a practical tool for translating the principles of Agenda 21 into reality, the CBD recognizes that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. A major change from the past brought in by the CBD is the sovereign rights of the States over their biodiversity. The CBD also declared that the States are responsible for conservation and sustainable use of their biological diversity in a manner benefiting the present and future generations, and ensuring fair and equitable sharing of the benefits arising out of the utilization of any component of biological diversity or associated TK. The States also are required to protect the rights of its people who conserve the biodiversity and associated TK**.**

The Background

Article 8(g) of the CBD states that "Each Contracting Party (CP) shall establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms (LMOs) resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health". Article 19(3) further states that "The Parties shall consider the need for and modalities of a protocol setting out appropriate procedures, including, in particular, advance informed agreement, in the field of the safe transfer, handling and use of any LMO resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity." Article 28 of CBD authorizes the CPs to cooperate for formulating and adopting protocols to this Convention. Thus, CPB was spawned by the CBD to prevent or minimize the adverse environmental impacts from LMOs that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to the health human and environment. The CBD, however, did not define the term "living modified organisms" but it is understood to include genetically modified organisms (GMOs), provided they are live.

Agenda 21, which was a precursor to the CBD also sounded the need for environmentally sound management of biotechnology. While acknowledging the promises biotechnology makes for better health care, enhanced food security, improved supplies of potable water, more efficient industrial development processes for transforming raw materials, support for sustainable methods of afforestation and reforestation, and detoxification of hazardous wastes. Agenda 21 stressed that the community at large can only derive full benefit from

biotechnology if it is developed and applied judiciously and safely to prevent the adverse impacts that LMOs may have on the conservation and sustainable use of biological diversity.

Precautionary Principle

All above statements admiring the potential promises of biotechnology had been couched on a precautionary note. Precautionary approach is also evident in Principle 15 of The Rio Declaration on Environment and Development, in the preamble of the CBD, its Art 16 dealing on biotechnology transfer as well as in the proviso 19(3) referred earlier. Rio Declaration is one of the most important international expressions of the precautionary principle, the seminal affirmation that led to the Biosafety Protocol. The concern is amply integrated in the Protocol and its Annex III, where it states "lack of scientific knowledge or scientific consensus should not necessarily be interpreted as indicating a particular level of risk, an absence of risk, or an acceptable risk". The precaution is essentially with reference to the regulation of LMOs because of lack of scientific certainty and consensus as to their potential impacts on the environment and human health.

The precautionary principle is said to have its beginnings in the German principle of *Vorsorge*, or foresight. Precaution has three elements: (1) threats of harm; (2) scientific uncertainty; and (3) preventive, precautionary action. The litmus test for knowing when to apply the precautionary principle is the combination of threat of harm and scientific uncertainty. This principle was introduced in 1984 at the First International Conference on Protection of the North Sea. Later, it was integrated into numerous international conventions and agreements, including the Bergen declaration on sustainable development, the Maastricht Treaty on the European Union, and the Global Climate Change Convention. Precautionary is different from preventive approach. When there is certainty about cause and effect, then the approach is preventive and not precautionary. Statutory warning like "Smoking is injurious to health" is precautionary. Precautionary principle serves as a "speed bump" to new technology, ensuring that decisions about new activities are made thoughtfully and in the light of potential consequences. In essence, the precautionary principle provides a rationale for taking action against a practice or substance in the absence of scientific certainty rather than continuing the suspect practice while it is under or without study.

History of the Protocol

Pursuant to Article 19 (3) of the CBD, the Conference of the Parties (CoPs) in 1994 decided to establish an open-ended ad hoc group of experts nominated by Governments. After a meeting, these experts suggested establishment of an Open-ended Ad Hoc Working Group on Biosafety (BSWG). The second CoP meeting established the BSWG to develop a draft protocol on biosafety, specifically focusing on transboundary movement of any LMO resulting from modern biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity. The BSWG in 1999 submitted a draft text of the

Protocol, as well as the outstanding concerns of the Parties, for consideration by CoP. Consideration of the draft at an extraordinary meeting of the CoP on 22 February 1999, in Cartagena, Colombia was incomplete. The session resumed in Montreal from 24 to 29 January 2000, where the Cartagena Protocol on Biosafety to the CBD was adopted. In accordance with its Art. 36, the Protocol was opened for signature at the UN Office at Nairobi till 26 May 2000 and later at UN HQ in New York. On ratification of the Protocol by 50 countries and subsequent elapsing of 90 days, the CPB entered into force on 11 September, 2003. At that time it had received 103 signatures. As of October 2008, 150 countries are Party to the Protocol.

The Protocol

The text of Cartagena Protocol on Biosafety (CPB) has a preamble, 42 Articles with three annexes. The Protocol defines "LMO" as any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology.

Objective of the Protocol

In accordance with the precautionary approach, the objective of this Protocol is to contribute to ensuring an adequate level of protection during transboundary movement, transit, handling and use of LMOs, that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health. CPB does not deal the transboundary movement of LMOs which are pharmaceuticals for humans.

General Provisions of the Protocol require each Party to take appropriate legal, administrative and other measures to implement its obligations under this Protocol. It also declares that nothing in this Protocol shall be interpreted as restricting the right of a Party to take action that is more protective of the conservation and sustainable use of biological diversity than that called for in this Protocol, provided that such action is consistent with the objective and the provisions of this Protocol and is in accordance with that Party's other obligations under international law.

National Measures for Implementation of the Protocol

Each Party is required to make legislations or regulations consistent with the protocol for implementing its obligations. Such national framework is required to designate a unified entity or separate entities as national focal point (NFP) and one or more competent national authorities (CNA). The NFP, on its behalf will be liaising with the Secretariat of the CBD and the Biosafety Clearing-House (BCH) and the CAN shall be responsible for the administrative functions required by this Protocol. On regulation of transboundary movement of LMOs pertaining to its jurisdiction, a Party has right to apply its own domestic regulatory framework, so long as it is in place and consistent with the Protocol (Art. 9(3) and Art. 14(4)).

The Biosafety Clearing-House

The BCH is established at the CBD Secretariat to facilitate the exchange of scientific, technical, environmental and legal information on, and experience with, LMOs and to assist Parties to implement the Protocol. It may also serve as a hub for accessing other international biosafety information exchange mechanisms. Each Party, without prejudice to the protection of confidential information, shall make available all relevant information that is required to the BCH. The information may include existing laws, regulations and guidelines for Protocol implementation at national level and information required by the Parties for the AIAP, bilateral, regional and multilateral agreements and arrangements, generated summaries of its risk assessments or environmental reviews of LMOs, decisions of Parties on the importation or release of LMOs, and national reports on implementation of its obligations under this Protocol,

Differential Treatment for Different Classes of LMOs

While the scope of the Protocol is on transboundary movement, transit, handling and use of all LMOs that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, it proposes different kind of treatment to different classes of LMOs. These classes are determined based on the risks posed by the LMOs on their exposure to environment, method of their handling, the nature their transboundary movement, and potentially possible adverse effects from them. For example, those classes of LMOs which are pharmaceuticals for humans are not dealt under the Protocol. Among the LMOs dealt under this Protocol, the class destined for contained use is dealt differently from the other class of LMOs, which are intended for introduction into the environment. The first transboundary movement (import) of LMOs intended for introduction into the environment of the country of import is to be done only after advance informed agreement procedure (AIAP).

Application of the Advance Informed Agreement Procedure

The AIAP is an important step provided in the Protocol to regulate transboundary entry of LMOs, which may adversely impact the conservation and sustainable use of biological diversity, taking also into account risks to human health. This has to be effectively applied prior to the transboundary movement. The AIAP involves few steps including risk assessment, risk management and risk communication. The AIAP applies to the first time a country is allowing transboundary movement of a given LMO of the class requiring such procedure. The steps of the procedure are:

- Notification by the Party of export (PoE);
- Acknowledgement of the receipt of notification by the Party of import (PoI); and
- Decision by the PoI on the notification.

The notification has to be in writing and addressed to the CAN of the PoI well ahead of the intentional transboundary movement of a LMO. Such notification should include the minimum information on the LMO, which is legally accurate, as prescribed in the Protocol (Annex I). With respect to the information being shared, the PoE has a privilege to request the PoI for treating any specified part of the shared information as confidential. The right to maintain confidentiality of information is discussed later.

Under the acknowledgement process, the PoI shall acknowledge in writing the receipt of the notification from the PoE, normally within 90 days of receipt of notification. Such acknowledgement shall state the date of receipt of the notification, whether the notification has all specified information and in required detail, and whether the import shall be in compliance with the domestic regulatory framework of the PoI (in case the PoI has such national framework). However, a failure by the PoI to make such acknowledgement shall not be construed as its consent to an intentional transboundary movement.

One of the important consideration for making a decision by the PoI is risk assessment on the LMO in question, which at minimum shall be done in accordance with the steps laid down in the Protocol (Annex III), deploying recognized risk assessment techniques, at a minimum, based on the information provided by the PoE and available scientific evidence in order to identify and evaluate the possible adverse effects of the LMO. It is important that PoI shall ensure that its decisions on import are based on risk assessments carried out in scientifically sound manner. Risk assessment may be done by the PoE or if so requires, the PoE shall bear the cost of risk assessment. (Please see more details in lecture on “Risk assessment”).

The POI within 90 days of receipt of notification shall, in writing, inform the PoE whether the intentional transboundary movement may proceed only after it has given its written consent or after no less than 90 days without a subsequent written consent. The decision of the PoI on transboundary movement of the LMO in question shall be conveyed in writing to the PoE as well as to the BCH, within 270 days of the date of receipt of notification. Such decision may be affirmative, with or without conditions and also indicating whether the decision shall apply to subsequent imports of the same LMO, or negative or requesting additional relevant information in accordance with its domestic regulatory framework or Annex I, along with extension of time for completing the process. Whenever the decision is other than non-conditional affirmation, the relevant reasons justifying such decision have to be conveyed. The lack of scientific certainty due to insufficient relevant scientific information on the potential adverse effects of a LMO shall not prevent a PoI from taking a decision in order to avoid or minimize such potential adverse effects. Also, failure by the PoI in conveying its decision within stipulated 270 days shall not be interpreted as consent to an intentional transboundary movement.

Confidential Information

The PoE has privilege to classify some of the information on the LMO or associated matters exchanged under AIAP as confidential and request PoI that it shall be treated accordingly. When called up on, the PoE is required to offer justification for such classification of information. The PoI also has privilege to question the propriety of such classification and any disclosure of such 'confidential' information by the PoI has to be done only after prior notice to the PoE, including opportunity for consultation and internal review of such decision. All such information concurred up on as 'confidential' has to be protected most effectively like one's own confidential information. The PoI shall also not use such confidential information for commercial purpose, unless with written consent. In the event of the PoE withdrawing the notification, all information classified as confidential by the PoE have to be totally respected by the PoI. Normally following information are not considered confidential: the name and address of PoE, general description of the LMO, a summary of the risk assessment conducted in accordance with the Protocol, and any methods and plans for emergency response.

Review of Decisions

Having a PoI taken a decision regarding the grant of intentional transboundary movement, it is entitled to review and change the decision, if required, in light of new scientific information on potential adverse effects on the conservation and sustainable use of biological diversity, taking also into account the risks to human health. Such decision, along with the reasons for the same, has to be conveyed to the PoE and the BCH within 30 days. Following this the PoE could request the PoI to review the decision either on the basis of a change in circumstances that has influenced the outcome of the risk assessment upon which the decision was based or on the basis of additional relevant scientific or technical information that has become available. This request from PoE for revised decision shall be responded by the PoI within 90 days along with the reasons for its decision. In this context, the PoI has right to demand a risk assessment for subsequent imports.

Simplified procedure

The Protocol also offers a simplified procedure for cutting time and pre-grant processes. This provides a PoI, on having applied adequate measures to ensure the safe intentional transboundary movement of LMO, to notify the BCH in advance the cases of intentional transboundary movement that may take place in to it and LMOs exempted from the AIAP during their import. Such notification to the BCH should be as specified in the Annex I.

LMOs Excluded from the AIAP

LMOs destined for different uses or moving along different routes are exempted from the AIAP by the Protocol. These are:

- LMOs intended for direct use as food or feed, or for processing (Art. 7 (2))
- LMOs identified in a decision of the CoP serving as the MoP to this Protocol as being not likely to have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health (Art 7 (4)).
- LMOs in transit, but going through a country towards its final destination elsewhere (Art. 6(1)).
- LMOs destined for contained use, like seeds and genetic material brought for experimental use and research (Art. 6(2)).
- Intentional trans-boundary movements in pursuant of bi- or multi-lateral agreements and arrangements among Parties to the Protocol (Art.14).

The exclusion of certain of above categories of LMOs from the purview of AIAP had generated considerable concern among many developing country Parties during negotiation of the Protocol. Hence *the Protocol has offered a way out by providing flexibility to Parties with right to regulate import of these LMOs in their domestic legislation* (Art. 11(6)).

Procedure for LMOs Intended for Direct use as Food or Feed, or for Processing

The LMOs intended for direct use as food, feed or for processing constitute a distinct class of LMOs, which are either traded or transported across national boundaries, or moved under food aid and other kinds of emergency support. More frequently these LMOs are crop or livestock produces or derivates, which may be subject to transportation inside the territory of the PoI, marketed across, or processed as food or feed products, etc like any other crop or livestock produce.

A PoI, either on the request of a PoE or on its own, may take a decision on transboundary movement of a LMO, which is either fit for direct use as food or feed, or for such use after processing, for domestic use and internal marketing. On having taken such decision, within 15 days of making that decision, the PoI shall inform the other Parties through the BCH. The information provided by the PoE shall be at least in accordance with the Annex II of the Protocol and legally accurate. Such minimum information shall include apart from identity of applicant, specific identity of LMO, details of gene modification, technique used and resulting characteristics of the LMO, particulars of taxonomy, source of origin, etc, known centres of origin and genetic diversity of the species, habitat description, approved use of LMO, risk assessment report consistent with Annex III of the Protocol, advisories on safe handling, storage, transport, use, etc. This information shall also be provided, in writing, to the NFP of each of those Parties, which had notified the Secretariat that it does not have access to the BCH. This provision, however, shall not apply to decisions regarding field trials.

A decision on the import of this class LMOs shall also be in compliance with the domestic regulatory framework of the PoI, where ever such framework exists and such framework is consistent with the objective of this Protocol. When Parties have laws, regulations and guidelines applicable to the import of LMOs of this class, these documents shall be deposited with the BCH. For developing countries and countries with economy in transition, the Protocol provides flexibility to declare through the BCH, in exercise of their domestic jurisdiction, that their decision prior to the first import of this class of LMOs shall be taken on the basis of risk assessment undertaken in accordance with the Protocol and the decision made thereof be made available within 270 days. Nonetheless, failure by a Party to communicate its decision within 270 days shall not be construed as its consent or refusal to the import of the LMO of this class.

As precaution is the underlying principle of the Protocol, lack of scientific certainty either due to insufficient relevant scientific information or knowledge regarding the extent of the potential adverse effects of a LMO on the conservation and sustainable use of biological diversity in the PoI, taking also into account risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of that LMO intended for direct use as food or feed, or for processing, in order to avoid or minimize such potential adverse effects.

A PoI may also indicate its needs for financial and technical assistance and capacity-building with respect to this class of LMOs and in such cases Parties shall cooperate to address these needs in accordance with the provisions on capacity building and public awareness.

Bilateral, Regional and Multilateral Agreements and Arrangements

In the current era of globalization and regional, bilateral or plurilateral agreement on trade in commodities including the LMOs, there is need for space to such agreements and arrangements. Hence the Protocol allows Parties to enter into bilateral, regional and plurilateral agreements and arrangements regarding intentional transboundary movements of LMOs. The Protocol insists that such agreements and arrangements have to be consistent with the objective of this Protocol and should not in any way lower the level of protection provided for by the Protocol. These agreements and arrangements that have been entered into before or after the date of entry into force of this Protocol, shall be informed to the Parties through the BCH. When agreements and arrangements are invoked on the intentional transboundary movements between the concerned parties, the provisions of this Protocol on that aspect shall not be operational. However, nothing shall prevent a Party from applying its domestic regulations with respect to specific imports into it and such decision shall be notified to the BCH.

Unintentional Transboundary Movements and Emergency Measures

There are many chances for unintentional transboundary movement of LMOs by natural causes like pollen transfer across geographical boundaries, or by human errors. Such occurrence within the jurisdiction of a Party may either affect adversely or potentially on the conservation and sustainable use of biological diversity, taking also into account risks to human health. Such occurrences shall be reported to the BCH and other relevant international organizations. Such reports should include the estimated quantities and relevant characteristics and/or traits of the LMO; the circumstances of release; estimated date of the event; on the use of the LMO in the originating Party; information about the possible adverse effects on the conservation and sustainable use of biological diversity and risks to human health; about possible risk management measures; any other relevant information; and a point of contact for further information.

Towards minimizing any significant adverse effects by such transboundary movement, each Party, from whose jurisdiction the movement of the LMO had occurred shall immediately consult the affected or potentially affected Parties, enable them to determine appropriate responses and initiate necessary action, including emergency measures.

Transboundary Movements of LMOs Involving Non Parties

As of now only 150 countries are Party to CPB. This offers scope for transboundary movements of LMOs between the jurisdictions of Parties and non-Parties to the Protocol. Under the Vienna Convention on the Law of Treaties, a protocol cannot create rights and obligations for non-Parties without their consent. However, when the involved Parties are members of bilateral, regional and plurilateral agreements or arrangements, the issue may be settled within that framework. If that is not the case with respect to the non-Party, the latter may be encouraged to voluntarily adhere to the CPB and to contribute appropriate information to the BCH on LMOs released in, or moved into or out of, areas within their national jurisdictions.

Illegal Transboundary Movements

Protocol provides measures to be followed to monitor and check illegal transboundary movement of LMOs that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health. These measures include regulations at domestic level and penalizing illegal transboundary movements. In the event of an illegal transboundary movement, the affected Party may request the Party of origin to dispose, at its own expense, of the LMO in question either by repatriation or destruction. The information concerned shall be communicated to the BCH by each Party. The preventive or punitive measures are however not easy when natural contamination takes place.

Liability and Redress

This pertains to the rules and procedures in the field of liability and redress for damage resulting from transboundary movements of LMOs. The Protocol text does not contain any provisions on this aspect. This is an area which faced strong conflict during negotiation. The matter was referred as an outstanding issue to the first meeting of the Parties to this Protocol.

Institutional Arrangements

Institutional mechanism provided in the Protocol includes those mechanisms for implementation of the Protocol at the level of each Party and those at the international level. The institutional mechanisms at the level of each Party level include the National laws and regulations on the biosafety consistent with Protocol, Competent National Authority and National Focal Points, and country-level Biosafety Clearing-House. The institutional mechanisms at the International level include CoP of the CBD, Meeting of the Parties (Protocol), BCH, the Protocol Secretariat (which is the CBD Secretariat), and other relevant international institutions. (For details consult Art.: 19, 29, 30 and 31).

Dispute Settlement

The Protocol provides no specific provision in on the settlement of disputes arising from its implementation and interpretation. But it falls back to the relevant provisions of the CBD in this respect (Article 32). Article 27 of the CBD provides for optional recourse to judicial settlement or arbitration, or a conciliation procedure that is mandatory at the request of one of the parties to a dispute. With a view to minimize disputes, the Protocol mandates the CoP-MoP to develop procedures and mechanisms to promote compliance with the provisions of the Protocol (Art. 34). In the case of international trade in LMOs, it is governed by the Protocol as well as the rules of the relevant WTO Agreements. This overlap and existence of a powerful dispute settlement mechanism under WTO, renders the Protocol subordinate to the WTO in the LMO-trade related disputes.

Capacity-Building and Financial Resources

The financial resource for the implementation of this Protocol is generated in accordance with the Art. 20 of the CBD. Similarly, the financial mechanism established in Art. 21 of the CBD (operated by the GEF) shall be serving as the financial mechanism for this Protocol. In this respect, biosafety issues may be “competing” with other biodiversity issues for financial support from the GEF.

Development and strengthening of HR and institutional capacities in biosafety, including biotechnology relevant to the biosafety assume high importance for the purpose of the effective implementation of this Protocol in country Parties, particularly the developing, the least developed, small island developing states, and countries with economies in transition.

The Protocol has no specific finance generation plan or specific guidance on the level of financial resources needed for implementation. A number of capacity-building initiatives in relation to biosafety are already underway since some time.

Public Awareness and Participation

Each Party is required to promote and facilitate public awareness, education and participation concerning the safe transfer, handling and use of LMOs in relation to the conservation and sustainable use of biological diversity, taking also into account risks to human health. And this may be done in cooperation with other States and international bodies. Such public awareness and education should encompass access to information on LMOs imported in accordance with this Protocol. Involvement of public in the decision-making through transparent consultative process, while respecting confidentiality of relevant information is important. The public needs to be informed about the means of public access to the BCH.

Socio-Economic Considerations

Any decision of a Party to import a LMO should carefully weigh, consistent with its international obligations and socio-economic considerations, the risks arising from the impact of LMOs on the conservation and sustainable use of biological diversity, especially with regard to the value of biological diversity to indigenous and local communities. Cooperation of Parties on research and information exchange on any socio-economic impacts of LMOs on indigenous and local communities is encouraged.

The international framework: The Codex Alimentarius, the World Organization of Animal Health, the International Plant Protection Convention, and the Agreement on Sanitary and Phytosanitary Measures

For many foods, the level of food safety generally accepted by the society reflects the history of safe consumption by these societies. It is recognised that in many cases the knowledge required to manage the risks associated with foods has been acquired in the course of their long history of use. Foods are generally considered safe, provided that care is taken during development, primary production, processing, storage, handling and preparation. Similarly, movements of live plants and animals as well as the commodities therefrom are also regulated both within and across countries to prevent concurrent spread of serious plant or animal pests and diseases as well as possible emergence of alien invasive species. Earliest food safety and quality laws are reported to have introduced in the Austro-Hungarian Empire between 1897 and 1911, where a collection of voluntary standards and product descriptions for a wide variety of foods was developed as the *Codex Alimentarius Austriacus*. With later expansion of trade in food, plants or animals, across countries, they had developed their own

mandatory laws/ regulations to define their standards. However, these standards and enforcement varied across countries causing risks to consumer health or threat to the health and safety of animals and plants. Similarly, food standards higher than what is scientifically justifiable are also foisted as non-tariff barriers to trade in food and farm commodity. These concerns resulted in establishing a collection of internationally harmonized and scientifically validated safety standards, which could serve as a benchmark, to protect the health of people, animals and plants, to promote fair trade and to settle disputes between countries arising from safety standards applied in trade. Towards evolving such internationally harmonized and scientifically validated safety standards three major intergovernmental mechanisms to protect of people, animals and plants, particularly to prevent the undesirable consequences of international movements of people and traded goods are established under the auspices of FAO and WHO. These are:

- **Codex Alimentarius Commission (CAC)**, which sets sanitary and technical standards for food safety, including food standards for commodities, codes of hygienic or technological practice, limits for pesticide residues in foods, and standards for contaminants and food additives;
- **Office International des Épizooties (OIE)**, which deals with animal health and zoonoses, and sets sanitary standards for the international movement of animals or animal products.
- **International Plant Protection Convention (IPPC)**, which provides international phytosanitary standards on how to prevent the spread and introduction of pests of plants and plant products;

The standards developed under these mechanisms have following key features in common:

- They are designed to protect the environment and human health while facilitating international trade and traffic.
- They are designed to be transparent and to harmonize regulations for trade and international traffic so that their application should remove artificial trade barriers and other causes of trade disputes between countries.
- They are developed on the basis of best scientific knowledge at that time (which implies revision in sync with advancing scientific knowledge).

Codex Alimentarius Commission

CAC is an inter-governmental body established in 1963 by joint covenant of the two organizations of United Nations, the Food and Agriculture Organization and the World Health Organization. The main tasks of the CAC as set out in Article 1 are as follows:

(a) protecting the health of consumers and ensuring fair practices in the food trade;

(b) promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations;

(c) determining priorities and initiating and guiding the preparation of draft standards through and with the aid of appropriate organizations;

(d) finalizing draft standards after acceptance by governments, publishing them in a Codex Alimentarius either as regional or global standards, together with international standards already finalized by other bodies, wherever this is practicable;

(e) amending published standards, after appropriate survey in the light of developments.

Codex Alimentarius (Latin, meaning Food Law or Code) is a collection of internationally adopted food standards presented in a uniform manner along with provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures to assist in achieving the purposes of the Codex Alimentarius (CA). Two landmark years in the foundation of the CA were 1960 and 1961. In October 1960, the first FAO Regional Conference for Europe recognized a widely held view on: "*[t]he desirability of international agreement on minimum food standards and related questions (including labelling requirements, methods of analysis, etc.) ...as an important means of protecting the consumer's health, of ensuring quality and of reducing trade barriers, particularly in the rapidly integrating market of Europe"*. The Conference also felt that: *"... coordination of the growing number of food standards programmes undertaken by many organizations presented a particular problem"*. Subsequent discussions among the FAO, the WHO, the United Nations Economic Commission for Europe (UNECE), the Organisation for Economic Co-operation and Development (OECD) and the Council of the *Codex Alimentarius Europaeus* reached to a proposal, which led to the establishment of an international food standards programme. In November 1961, the Eleventh Session of the FAO Conference passed a resolution to set up the CAC. In May 1963, the Sixteenth World Health Assembly approved the establishment of the Joint FAO/WHO Food Standards Programme and adopted the statutes of the CAC.

The CA includes all the main foods encompassing of processed, semi-processed or raw, materials used in the further processing of food products, hygienic and nutritional quality of food, including microbiological norms, food additives, pesticide and veterinary drug residues, contaminants, labelling and presentation, and methods of sampling and risk analysis. It also includes individual standards, advisory codes of practice, guidelines and other recommended measures. The CA is a single most important international reference point on food biosafety for consumers, food producers and processors, national food control agencies and the international food trade-like a unified global food code. The CA presents a unique opportunity for all countries to join the international community in formulating and harmonizing food standards and ensuring their global implementation. It also allows them a role in the development of codes governing hygienic processing practices and recommendations relating to compliance with those standards. National food safety measures and regulations are evaluated against this benchmark, particularly in the context of international food trade. There is an advantage in having universally uniform food standards for the protection of consumers. The two WTO agreements, namely, the SPS Agreement and the TBT Agreement further

promote the international harmonization of food standards. These Agreements cite international standards, guidelines and recommendations as the preferred measures for facilitating international trade in food. As such, Codex standards have become the benchmarks against which national food measures and regulations are evaluated within the legal parameters of the World Trade Organization (WTO) Agreements.

Food-borne illnesses are at best unpleasant and at worst they can be fatal. The other consequences are outbreaks of food-borne illness, damaging trade and tourism and also leading to loss of earnings, unemployment and litigation. Poor quality food can destroy the commercial credibility of suppliers, both nationally and internationally, while food spoilage is wasteful and costly and can adversely affect trade and consumer confidence. The Codex system also contributes in sensitizing the global community on the importance of food quality and the need for food standards to prevent the danger of food hazards. A formal evaluation of the Codex programme undertaken by FAO and WHO in 2002 found among other things, there is need for increased inclusiveness of developing member countries in the Codex standard development process, including risk assessment and more effective capacity-building for development of national food control systems.

Codex Standards

The two basic aspects for the food safety concerns are the "visible" and "invisible" aspects. The "visibles" include underweight, size variations, misleading labelling and poor quality. The "invisibles" comprise the hidden health hazards, smell or taste, such as microbial contamination, pesticide or chemical residues, adulterants, food additives and environmental contaminants.

Codex standards normally refer to one or more product characteristics appropriate to a commodity depending on how many of these characteristics are regulated by the government. These standards include general as well as commodity specific standards, such as standards for food additives and contaminants and toxins in foods. Because standards relate to product characteristics, they can be applied wherever the products are traded. For example, maximum residue limits (MRLs) for residues of pesticides or veterinary drugs, etc in foods. The Codex General Standard for the Labelling of Prepackaged Foods covers all foods in this category. *Codex methods of analysis and sampling*, including those for contaminants and residues of pesticides and vet drugs in foods, are also considered as Codex standards. *Codex codes of practice* includes codes of hygienic practice, which define the production, processing, manufacturing, transport and storage practices for individual foods or groups of foods that are considered essential to ensure the safety and suitability of food for consumption. A code of practice on the control of the use of veterinary drugs provides general guidance in this area. For food hygiene, the basic text is the Codex General Principles of Food Hygiene, which introduces the use of the Hazard Analysis and Critical Control Point (HACCP) food safety management system.

Codex guidelines fall into two categories: (1) principles that set out policy in certain key areas; and (2) guidelines for the interpretation of these principles or for the interpretation of the provisions of the Codex general standards. In the cases of food additives, contaminants, food hygiene and meat hygiene, the basic principles governing the regulation of these matters are built into the relevant standards and codes of practice. *Interpretative Codex guidelines* include those for food labelling, especially the regulation of claims made on the label. These guidelines pertain to nutrition and health claims; conditions for production, organic foods; and foods claimed to be "halal". There are also free-standing *Codex principles* covering more guidelines that interpret the provisions of the Codex for Food Import and Export Inspection and Certification, guidelines on the conduct of safety assessments of foods from DNA-modified plants and micro-organisms, the Establishment and Application of Microbiological Criteria for Foods, Levels for Radio-nuclides in Foods following Accidental Nuclear Contamination for Use in International Trade and the conduct of microbiological risk assessment.

By far the largest number of (more than 200) specific standards in the CA is the group called "commodity standards". These standards include individual foods within groups of foods and groups of commodities. Commodity standards tend to follow a fixed format defined in the *Procedural Manual of the CAC*. In this category, there are nine groups of foods as follows:

- Cereals, pulses & derived products including vegetable proteins
- Fats and oils and related products
- Fish and fishery products
- Fresh fruits and vegetables
- Processed and quick-frozen fruits and vegetables
- Fruit juices
- Meat and meat products; soups and broths
- Milk and milk products
- Sugars, cocoa products & chocolate & other miscellaneous products

Functional framework of CAC

Eligibility for membership of the Commission, which is open to all Member Nations and Associate Members of FAO and WHO, is defined in Article 2. The Commission is truly an international body. Currently (as on December 2008) the CAC is participated by 177 countries. The Commission normally meets once in two years, alternately at FAO headquarters in Rome and at WHO headquarters in Geneva. On occasions, it may meet more frequently or in special or extraordinary sessions.

The Codex Alimentarius Commission at its Secretariat at FAO headquarters in Rome is constituted by elected Chair person and three Vice Chair persons, who are on tenure, and an

Executive Committee. The Executive Committee assists the Commission on reviewing project proposal and determines its relevance on the basis of established criteria and priorities. Day to day administration is entrusted with the Secretary of the Codex Alimentarius Commission, who is appointed jointly by the Director-Generals of FAO and WHO following an open worldwide search. The Secretary is supported by a small staff of professional and technical officers. The Commission at every member country level has *Codex Contact Points* constituted by the national governments. Many members also have *National Codex Committees* to coordinate activities nationally. National Codex Committees at each the six regions are coordinated by the *Coordinating Committees*. The six regions are Asia, Near East, Africa, Europe, Latin America and Caribbean, and North America and Southwest Pacific. The coordination ensures that the work of the Commission is responsive to regional interests and to the concerns of developing countries. The country that chairs the Coordinating Committee is also the *Regional Coordinator* for the region concerned. The Secretariat and the regional coordinators constitute the core administrative framework.

Under its Rules of Procedure, the CAC is empowered to establish two kinds of subsidiary body. These are (1) *Codex Committees*, which prepare draft standards for submission to the Commission; and (2) *Coordinating Committees*, which coordinate food standards activities in the region, including the development of regional standards. A feature of the committee system is that, with few exceptions, each committee is hosted by a member country, which is chiefly responsible for the cost of the committee's maintenance and administration and for providing its chairperson.

There two kinds of Codex Committees. These are the General Subject Committees (GSCs) and the Commodity Committees. The GSCs are so called because their work has relevance for all Commodity Committees and often applies across the board to all commodity standards. These Committees are also referred to as "horizontal committees". GSCs develop all-embracing concepts and principles applying to foods in general, specific foods or groups of foods; endorse or review relevant provisions in Codex commodity standards; and, based on the advice of expert scientific bodies, develop major recommendations pertaining to consumers' health and safety. The GSCs advise the CAC on such basic matters as definitions, the Rules of Procedure, rules and working procedures for the establishment and operation of Codex Committees and Task Forces, relations with other organizations and the general principles that underlie the preparation of all Codex standards, codes of practice and other texts. The six GSCs are the Committee on Food Additives; on Contaminants in Foods; on Food Hygiene; on Food Labelling; on Methods of Analysis and Sampling; and on Nutrition and Foods for Special Dietary Uses. The Committee on Pesticide Residues and the Committee on Residues of Veterinary Drugs in Foods prepare MRLs for these two categories of chemicals used in agricultural production. The Committee on Food Import and Export Inspection and Certification Systems deals with the application of standards to foods moving in international trade, in relation to the regulatory measures applied by governments.

The responsibility for developing standards for specific foods or classes of food lies with the Commodity Committees (CCs). In recognition of their exclusive responsibilities, they are often referred to as "vertical committees". CCs are constituted and abolished on need basis. The common five CCs are Committees on Fats and Oils; on Fish and Fishery Products; on Fresh Fruits and Vegetables; on Milk and Milk Products; and on Processed Fruits and Vegetables.

A third type of subsidiary body called a Codex ad hoc Intergovernmental Task Force is a Codex Committee with very limited terms of reference established for a fixed period of time. The following ad hoc Intergovernmental Task Forces are constituted till date: Task Force on Animal Feeding, 1999–2004; Task Force on Foods Derived from Biotechnology, 1999–2003 and 2005–2009; Task Force on Fruit and Vegetable Juices, 1999–2005; Task Force on the Handling and Processing of Quick Frozen Foods, 2006-; and Task Force on Antimicrobial Resistance, 2006- .

Guidelines of *Ad hoc* Intergovernmental Task Force on foods derived from Modern Biotechnology

The CAC at its 26th session in 2003 adopted Principles and Guidelines on foods derived from biotechnology. These are overarching principles on the risk analysis of foods derived from modern biotechnology and guidelines for food safety assessment of foods derived from recombinant-DNA plants and microorganisms. Guideline for the conduct of food safety assessment provide two major sections, one on foods derived from recombinant-DNA plants and the other on food produced using recombinant-DNA microorganisms. The conduct of risk analysis is guided by general decisions of the CAC as well as the Codex Working Principles for Risk Analysis. The Risk Analysis of Foods Derived from Modern Biotechnology does not address animal feed or animals fed with the feed or the environmental risks.

Risk assessment includes a safety assessment, which is designed to identify whether a hazard, nutritional or other safety concern is present, and if present, to gather information on its nature and severity. The safety assessment should include a comparison between the food derived from modern biotechnology and its conventional counterpart focusing on determination of similarities and differences. If a new or altered hazard, nutritional or other safety concern is identified by the safety assessment, the risk associated with it should be characterized to determine its relevance to human health. Risk analysis methodology and its application should be consistent with new scientific knowledge and other information relevant to this. With the availability of new scientific information, risk assessment may be reviewed to incorporate this information and, if necessary, with suitable adaptation of risk management measures.

Safety assessment on foods derived from recombinant-DNA plants

A safety assessment is characterized by comparative assessment the whole food derived from modern biotechnology and its conventional counterpart focusing on determination of similarities and differences with consideration to:

a) the intended and unintended effects;

b) identification of new or altered hazards;

c) identification of changes, relevant to human health, in key nutrients.

Risk management measures for foods derived from modern biotechnology should be proportional to the risk and these measures may include, as appropriate, food labeling, conditions for marketing approvals and post-market monitoring.

Due to difficulties in using animal models for assessing the risks associated with whole foods, a more focused approach is required for the safety assessment of foods derived from food plants, including recombinant-DNA plants. This has been addressed by the development of a multidisciplinary science-based approach for assessing safety which takes into account both intended and unintended changes that may occur in the plant or in the foods derived from it, on case by case, using the concept of substantial equivalence. The concept of substantial equivalence is not a safety assessment in itself; rather it represents the starting point which is used to structure the safety assessment of a new food relative to its conventional counterpart. The safety assessment of foods derived from recombinant-DNA plants involves methods to identify and detect any unintended effects and procedures to evaluate their biological relevance and potential impact on food safety. A variety of data and information are necessary to assess unintended effects because no individual test can detect all possible unintended effects or identify, with certainty, those relevant to human health. These data and information, when considered in total, provide assurance that the food is unlikely to have an adverse effect on human health.

The safety assessment of a food derived from a recombinant-DNA plant follows a stepwise process of addressing relevant factors that include: A) Description of the recombinant-DNA plant; B) Description of the host plant and its use as food; C) Description of the donor organism(s); D) Description of the genetic modification(s); E) Characterization of the genetic modification(s); F) Safety assessment, which may involve: i) expressed substances (non-nucleic acid substances); ii) compositional analyses of key components; iii) evaluation of metabolites ; iv) food processing; v) nutritional modification; and G) Other considerations. The goal of each safety assessment is to provide assurance, in the light of the best available scientific knowledge, that the food does not cause harm when prepared, used and/or eaten according to its intended use.

When the protein(s) resulting from the inserted gene is present in the food, it should be assessed for potential allergenicity in all cases. An integrated, stepwise, case-by-case approach used in the assessment of the potential allergenicity of the newly-expressed

protein(s) should rely upon various criteria used in combination (since no single criterion is sufficiently predictive on either allergenicity or non-allergenicity). Consideration should be given to the potential for the accumulation of metabolites in the food that would adversely affect human health. The potential effects of food processing, including home preparation, on foods derived from recombinant-DNA plants should also be considered. For example, alterations could occur in the heat stability of an endogenous toxicant or the bioavailability of an important nutrient after processing. The assessment of possible compositional changes to key nutrients should be conducted for all recombinant-DNA plants.

Safety assessment on foods produced using recombinant-DNA microorganisms

This addresses safety and nutritional aspects of foods produced through the actions of recombinant-DNA microorganisms. The recombinant-DNA microorganisms that are used to produce these foods are typically derived using the techniques of modern biotechnology either from strains that have a history of safe, purposeful use in food production or the recipient strains do not have a history of safe use. The risk assessment may be different in the case of these two types of recombinant-DNA microorganisms.

Effective risk communication is essential at all phases of risk assessment and risk management. It is an interactive process involving all interested parties, including government, industry, academia, media and consumers. Transparent safety assessment and risk management decision making processes should be part of the risk communication. These processes should be fully documented at all stages and open to public scrutiny, whilst respecting legitimate concerns to safeguard the confidentiality of commercial and industrial information. In particular, reports prepared on the safety assessments and other aspects of the decision-making process should be made available to all interested parties. Effective risk communication should include responsive and interactive consultation processes, where the views of all interested parties should be sought and relevant food safety and nutritional issues that are raised during consultation should be addressed during the risk analysis process.

Applying Codex standards

The two major concerns of the CAC are protecting the health of consumers and ensuring fair practices in the food trade. Harmonization of food laws of countries following internationally agreed standards is expected to largely address the above concerns. In addition to CA, the efforts on international harmonization of food standards are taken forward by the SPS and TBT Agreements. However, despite growing global interest in all Codex activities, in practice it is difficult for many countries to accept Codex standards in the statutory sense. Differing legal formats and administrative systems, varying political systems and sometimes the influence of national attitudes and concepts of sovereign rights impede the progress of harmonization. An increasing number of countries are aligning their national food standards,

or those relating to safety, with those of the CA. Such compliance is more in the case of invisibles such as additives, contaminants and residues.

Codex standards are also gaining recognition as reference point in some regional trade agreements/ trade groupings like NAFTA, MERCOSUR, and APEC for compliance by the member countries on safety of food products traded. The Mutual Recognition Arrangement on Conformity Assessment of Foods and Food Products approved by the APEC has consistency with the standards of SPS, TBT and Codex on food trade and Inspection and Certification Systems. Several other plurilateral and bilateral agreements have accepted Codex for benchmarking safety aspects of food products.

A Trust Fund launched in 2003 seeking US$ 40 million over a 12-year period is being established to help developing countries and countries in transition to increase their participation in the work of the Commission. This fund is leveraged to increase the participation of these countries both by assisting for the involvement of their regulators and food experts in activities on setting in international standards and enhancing their capacity for establishing effective domestic food safety and quality standards and fair practices in the food trade, both in the framework of the CA and in their own countries.

The World Organization of Animal Health

Many animal disease pandemics required fighting at global level. This led to the creation of the Office International des Epizooties (OIE) through the international Agreement signed on January 25th 1924 in Paris. In May 2003 this organization changed its name to the World Organisation for Animal Health, while keeping its historical acronym OIE. The OIE is the intergovernmental organisation with objective to work towards ensuring safe food world wide, by reducing animal food-borne risks to human health due to hazards arising from animals, globally fighting animal diseases and improving the safety of the " food production to consumption continuum". It works in tandem with FAO, WHO, the CAC and relevant Codex Committees and other organisations.

OIE is recognised as a referal organisation by the WTO. As on October 2008, OIE is joined by a total of 172 Member Countries and Territories. The OIE maintains permanent relations with 36 other international and regional organizations and has Regional and sub-regional Offices on every continent.

OIE provides guidance to Members on the role and responsibilities of National Veterinary Services - for educating and training the veterinarians in both animal health (including zoonoses) and food hygiene components- to equip them to play a central role in ensuring safety food of animal origin.

OIE defines a hazard as a biological, chemical or physical agent in food with the potential to cause an adverse health effect in humans, whether or not it causes disease in animals. The Third OIE Strategic Plan for 2001-2005 enlarged OIE activity to the area of public health and

consumer protection, including "zoonoses and diseases transmissible to humans through food, whether or not animals are affected by such diseases“. Zoonose is any infectious disease that is able to be transmitted (by a vector) from other animals, both wild and domestic, to humans or from humans to animals (the latter is sometimes called reverse zoonosis). In 2002, the OIE established a permanent Working Group on Animal Production Food Safety (APFSWG) to coordinate its food safety activities. The Working Group includes in its membership high-level experts from the FAO, the WHO, the CAC and relevant Codex Committees, and reflects a broad geographical basis. The fourth OIE Strategic Plan (2006-2010) continues this mandate, recommending that the APFSWG "continue to work with other relevant organisations, especially the CAC, in reducing food-borne risks to human health due to hazards arising from animals".

More recent pandemics witnessed by the world are mad cow disease or Bovine spongiform encephalopathy (BSE), Avian influenza (AI), and Severe Acute Respiratory Syndrome (SARS).

Bovine spongiform encephalopathy (BSE), or “mad cow disease (MCD)” erupted in UK in the 1980s was a fatal, neurodegenerative disease in cattle causing a spongy degeneration in the brain, spinal cord and retina. The causal agent is believed to be a specific type of misfolded protein called a prion. It is transmittable to humans eating the meat of infected animals to cause Creutzfeldt-Jacob disease (CJD). The first case of CJD was reported in the USA in December 2003. CJD was detected in UK and Europe. By April 2008, it had killed 204 people in these countries. While the origin of disease is unknown, it is believed the epidemic was caused by cattle being fed by meat and bone meal prepared from other cattle. This led Codex to take up feed safety of food-producing animals and evolving the Code of Practice on Good Animal Feeding, production and use of all materials destined for animal feed and feed ingredients at all levels, grazing or free-range feeding, forage crop production and aquaculture.

Severe Acute Respiratory Syndrome (SARS)

SARS is a respiratory disease in humans caused by the SARS coronavirus (SARS-CoV). During November 2002 and July 2003, SARS assumed near pandemic state with worldwide 8,096 known infected cases and 774 deaths (a case-fatality rate of 9.6%). The epidemics of SARS appear to have started in Guangdong Province, China in November 2002. Within a matter of weeks, SARS rapidly spread from the Guangdong province of China to some 37 countries around the world. SARS is believed to have occurred following breaches in laboratory biosafety, or human exposure to an animal reservoir or other environmental source.

Avian influenza (AI) is a highly contagious pandemic viral disease affecting several species of food producing birds (chickens, turkeys, quails, guinea fowl, etc.). Also affects pet birds and wild birds. Based on their pathogenicity, there are two types of AI viruses. Highly pathogenic AI virus (Eg. H5N1) spreads rapidly and causes serious disease and high mortality

rates (up to 100% within 48 hours). Symptoms of mild disease caused by low pathogenic AI (LPAI) are undetectable or no symptoms at all in some species of birds. The virus spreads to human and cause death. Till Sept 2008, 387 cases and 245 deaths due to AI are reported from 16 countries.

The OIE has established the *Terrestrial Animal Health Code* (also referred to as *Terrestrial Code*) to ensure the sanitary safety of international trade in terrestrial animals and their products. This is achieved through the detailing of health measures to be used by the veterinary authorities of importing and exporting countries to avoid the transfer of agents pathogenic for animals or humans, while avoiding unjustified sanitary barriers. The value of the *Terrestrial Code* is twofold: that the measures published in it are the result of consensus among the veterinary authorities of OIE Members, and that it constitutes a reference within the WTO on the Application of SPS Measures as an international standard for animal health and zoonoses. The health measures in the *Terrestrial Code* are in the form of standards and recommendations, and have been formally adopted by the OIE International Committee, the general assembly of all Delegates of OIE Members. The 17th edition of the *Terrestrial Code* revised in May 2008 includes revised chapters on general definitions, notification criteria for listing diseases, obligations and ethics in international trade, import risk analysis, the Veterinary Services, evaluation of Veterinary Services, zoning and compartmentalisation, animal health measures applicable before and at departure, border posts and quarantine stations in the importing country, international transfer and laboratory containment of animal pathogens, rabies, foot and mouth disease, rinderpest, contagious caprine pleuropneumonia, bovine tuberculosis, bovine spongiform encephalopathy, equine influenza, equine rhinopneumonitis, equine viral arteritis, African horse sickness, African swine fever, classical swine fever, avian influenza and Newcastle disease. The revision also includes alternative diagnostic tests for OIE listed diseases, on categorisation of diseases and pathogenic agents by the International Embryo Transfer Society, on inactivation procedures of foot and mouth disease virus and of avian influenza virus, on surveillance for bovine spongiform encephalopathy, for foot and mouth disease, for classical swine fever, for avian influenza and for bluetongue, on animal welfare (including introduction to the recommendations on animal welfare, transport of animals by sea, transport of animals by land, transport by air, slaughter of animals and killing of animals for disease control purposes), on factors to consider in conducting the bovine spongiform encephalopathy risk assessment as well as on model veterinary certificates have also been included.

This OIE draws upon the expertise of internationally renowned specialists to prepare draft texts for new articles of the *Terrestrial Code* or revise existing articles in the light of advances in veterinary science. The *Terrestrial Code* is published annually in paper form in the three official OIE languages (English, French and Spanish), and in Russian.

The document on the "Cooperation between the CAC and the OIE on Food Safety throughout the Food Chain" presents the regulatory perspective on the "food production to

consumption continuum" and establishes a context for the document on “The Role of Veterinary Services in Food Safety”. This document provides guidance to OIE Members on the role and responsibilities of national Veterinary Services. It notes that the education and training of veterinarians, which includes both animal health (including zoonoses) and food hygiene components, makes them uniquely equipped to play a central role in ensuring food safety, especially the safety of food of animal origin. In order for them to make the best possible contribution to food safety, it is important that the education and training of veterinarians meet high standards and that there are national programmes for ongoing professional training. The Veterinary Services should comply with the fundamental principles of quality in the *Terrestrial Code* and guidelines for the evaluation of Veterinary Services are provided in the *Terrestrial Code*. The document also highlights the need for cooperation with other authorities in the food chain continuum to ensure the protection of both animal and public health.

The International Plant Protection Convention

The International Plant Protection Convention (IPPC) is an international treaty to secure action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control by leveraging international cooperation. It is governed by the Commission on Phytosanitary Measures (CPM) which adopts International Standards for Phytosanitary Measures (ISPMs). The CPM has confirmed the IPP as the preferred forum for national IPPC reporting and the exchange of more general information among the phytosanitary community. At national and regional levels, IPPC is assisted by the National Plant Protection Organization (NPPO) and Regional Plant Protection Organization (RPPO), respectively. The IPPC is deposited with and governed by the FAO. The Secretariat of the IPPC located at the FAO, Rome coordinates the activities of the Convention. As of October 2008, the IPPC has 170 contracting parties.

History: The forerunner of the IPPC was a first international agreement for plant protection, the *Phylloxera vasatrix* Convention, concluded in Berne in 1881. The first draft of the IPPC was made in Rome in 1929. However, it was adopted only in 1951 at the Sixth session of the FAO and came into force in 1952 superceding all pre-existed international agreements on plant protection. The Convention was revised in 1979 and 1997. The Uruguay Round of negotiations on GATT recognized the IPPC as one of the standard-setting organizations for the SPS Agreement in 1989. The IPPC Secretariat was established and began standard-setting programme in 1992. The Committee of Experts on Phytosanitary Measures (CEPM) was first constituted in 1993. The first International Standard for Phytosanitary Measures (ISPM) was approved in 1995 by the 27th Session of the FAO. In the mean time, the SPS Agreement negotiated as part of the WTO came into force in 1995. The first meeting of the Interim Commission on Phytosanitary Measures was held in 1998. In 2001, the Standards Committee and dispute resolution procedures were established. The last

revision made in 1997 was wide ranging, based on the recommendations of an Expert Consultation held in 1996 as well as a review and further elaboration undertaken by a technical consultation on the Revision. The revised text of the Convention came into force with respect to all Contracting Parties (CPs) from 2 October 2005.

The existing Convention has 23 articles and model phytosanitary certificate for export and re-export. This document outlines the aims of the IPPC, its organizational structure and the major principles underpinning its implementation. The 1997-revised text of the IPPC provides a framework and a forum for international cooperation and harmonization and technical exchange between contracting parties dedicated to these goals. In addition to describing national plant protection responsibilities, it also addresses important elements of international cooperation for the protection of plant health and the establishment and use of ISPMs.

The Convention extends to the protection of natural flora and plant products. It includes both direct and indirect damage by pests (including weeds). The provisions extend to cover conveyances, containers, storage places, soil and other objects or material capable of harbouring plant pests. The Convention recognizes that countries have sovereign authority to use phytosanitary measures to regulate the entry of plants and plant products and other objects or material capable of harbouring plant pests. Countries can refuse entry, require treatment or specify other requirements for regulated material. In applying phytosanitary measures, CPs have obligations to comply with the Convention's principles of necessity, technical justification and transparency. For example, phytosanitary requirements must be applied only when made necessary by phytosanitary considerations, scientifically justified, consistent with the risk, the least restrictive measure available, and result in the minimum impediment to international trade and traffic. It is important phytosanitary measures are to be followed in consistence with the pest risk and the least restrictive measures available. The restrictive measures must also be modified if conditions change. All these are to be guided by an important principle that the phytosanitary measures are applied non-discriminatory manner between countries of the same phytosanitary status. All relevant information and the rationale for such measures must be promptly made available to any affected CPs, if requested. Under the international cooperation, parties have to exchange with other CPs their information on plant pests, in particular the reporting of any outbreak or spread of pests. Cooperation on such matters is established through the regional plant protection organizations which, in turn, cooperate with the IPPC Secretariat.

The IPPC has always been an important agreement to countries that trade in agricultural, horticultural and forestry products. As governments become more concerned by the adverse impact of weeds and other invasive organisms, not only on commercial crops but also on biodiversity and natural habitats, the Convention is assuming increasingly important role as a framework that can be applied to matters of environmental protection. The principal

organizations administering and implementing the IPPC are: (1) CPM (the ICPM prior to CPM); (2) IPPC Secretariat; (3) the FAO; (4) NPPOs; and (5) RPPOs.

The establishment of the CPM is a major development for the Convention. It provides a global forum for discussion of phytosanitary issues and allows a wide representation of contracting parties in work programmes and strategic planning. The CPM meets annually to implement the objectives of the Convention. It may also meet in more special sessions. CPs try to reach agreement by consensus on matters under discussion, although decisions can be taken by a two-thirds majority of the CPs present and voting, as a last resort. The main tasks of the CPM are:

- reviews global plant protection needs;
- develops and adopts ISPMs;
- establishes procedures for the resolution of disputes;
- promotes the provision of technical assistance to develop the phytosanitary capacity of contracting parties; and
- cooperates with RPPOs and other relevant international organizations on matters relating to the Convention.

Basic funding and resources for the work programme of the commission are currently provided by countries mainly through the FAO budget.

Initially, the IPPC Secretariat was established with the responsibility for coordinating the work programme for the global harmonization of phytosanitary measures. With the subsequent establishment of CPM, the roles of the IPPC Secretariat have shifted so that development of ISPMs has become a joint endeavour between the CPM and Secretariat. Thus the IPPC Secretariat implements the policies and activities of the CPM; publishes information relating to the IPPC; facilitates information exchange between CPs; and coordinates with the technical cooperation programmes of FAO to provide technical support on matters concerned to the IPPC, particularly to least developed nations. The FAO's Plant Protection Service is part of its agriculture department. In support of the IPPC, FAO provides the Convention's Secretariat through the Plant Protection Service; a source of legal advice; technical assistance projects and logistical back up for many of the activities of the international phytosanitary community.

NPPOs are listed on the IPPC Web site (www.ippc.int/IPP/En/default.jsp) together with their contact details. The principal roles, NPPOs are:

- responsibility for issuing phytosanitary certificates;
- managing surveillance for pest outbreaks and control of pests;
- conducting inspection and, if necessary, disinfestation of traded consignments of plants and plant products;
- ensuring phytosanitary security of consignments from certification until export;
- establishing and protecting pest free areas;

- undertaking pest risk analyses for the development of phytosanitary measures.

The last-mentioned three roles were invested with the NPPOs by the 1997 revision of the Convention to make them responsible and important in implementing the concepts of the Convention at a national level. Pest risk analysis (PRA), for example, is a modern phytosanitary practice which provides the technical justification for application of phytosanitary measures. A standardized wording and format are followed for official phytosanitary certificates so that such a certificate is easily recognized and contain the essential information describing the consignment.

RPPO is an intergovernmental organization providing coordination on a regional level for the activities and objectives of the IPPC as laid down in Article IX. The 1997 revised Convention extends the responsibilities of RPPOs to specify their cooperation with the IPPC Secretariat and CPM. The RPPOs are to participate in activities to achieve the objectives of the Convention; to disseminate information relating to the IPPC; and to cooperate with the CPM and the IPPC Secretariat in developing international standards.

Currently there are the following nine RPPOs:

- Asia and Pacific Plant Protection Commission (APPPC) with 24 members representing 24 countries;
- Caribbean Plant Protection Commission (CPPC) with 22 members representing 26 countries;
- Comite Regional de Sanidad Vegetal Para el Cono Sur (COSAVE) with five member countries;
- Comunidad Andina (CA) with five member countries;
- European and Mediterranean Plant Protection Organization (EPPO) with 41 member countries;
- InterAfrican Phytosanitary Council (IAPSC) with 51 member countries;
- North American Plant Protection Organization (NAPPO) with three member countries;
- Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA) with eight member countries;
- Pacific Plant Protection Organization (PPPO) with 21 members representing 25 countries.

Not all CPs to the IPPC are members of RPPOs, nor are all members of RPPOs CPs to the IPPC.

Standard setting

The process for developing an ISPM comprises three stages: a draft stage, consultation stage and approval stage. The time taken to go from proposal to approval varies between

standards, and usually not less than 12 months. Suggestions for topics for ISPMs can be made by the NPPOs and RPPOs, the IPPC Secretariat or the WTO-SPS Committee. Other organizations, such as the CBD, industry groups or individuals may submit proposals for standards (or amendments to existing specifications) through the IPPC Secretariat. Priorities for dealing with proposed standards are decided by the CPM in consultation with the Secretariat.

A Standards Committee oversees the standard-setting process and assists in the development of ISPMs. This committee (established by the CPM in 2001), comprises 20 members drawn from the seven FAO regions: two from North America and three from each of the other six regions. Members are senior experts designated by their governments and confirmed by the CPM. The Standards Committee selects from within its members a subgroup of seven experts, the Standards Committee Working Group (SC-7), to undertake detailed work on draft standards. The IPPC Secretariat provides administrative and technical support for the Standards Committee and prepares records and reports of the standard-setting process.

NPPOs, RPPOs or working groups duly established or Standards Committee draft the standard and submit it to the IPPC Secretariat. The draft then passes between the IPPC Secretariat and the Standards Committee. One of the members of the committee takes responsibility for overseeing development of a particular standard from draft to approval. The committee reviews the draft and recommends what further action is to be taken. The Secretariat and Committee may arrange for a technical working group or a consultant to modify a draft standard, if necessary. The Committee continues to review the standard and in due course recommends it for submission to governments for technical comment.

Suggestions by individual member countries and RPPOs for change should be supported by an explanation of their purpose and alternative text should be proposed where appropriate. This is considered by the Standards Committee which, in consultation with the IPPC Secretariat, determines the nature and extent of changes to be made to the draft in response to the comments received. Acceptance of a redrafted standard by the Standards Committee results in submission of the standard to the CPM. The redrafted standard is considered by the CPM, amended if necessary, and adopted. The standard is then published and distributed by the IPPC Secretariat.

Pest risk analysis (PRA) is an important element in preventing the spread and introduction of plant pests. PRA has become increasingly important in modern phytosanitary practice. It provides the technical justification for the application of phytosanitary measures. The CPM has agreed that addressing standards relating to PRA should be a priority for collaborative work with environmental organizations such as the CBD. Information gathering and record keeping are important aspects of PRA. Any PRA should be well documented so that the information sources and the decisions can be evaluated in the event of a review or a dispute over the chosen phytosanitary measures. There are general guidelines for PRA (ISPM

2) and specific PRA for quarantine pests (ISPM 11). A pest is assessed as a quarantine pest in terms of its potential economic importance and possible official control measures in the area endangered by its presence. Complete definitions of quarantine pest and of pest risk assessment and pest risk management as they apply to quarantine pests are published as part of the standard. Over all, the PRA has three stages, comprising pest risk analysis, pest risk assessment and pest risk management. Economic consequences are assessed in terms of direct and indirect pest effects, including the effects on domestic and export markets, particularly on market access. Any PRA must refer to a defined PRA area - an area within a country, the whole country or a region of countries.

Agreement on SPS Measures

This Agreement seeks to protect human, animal or plant life or health, subject to the requirement that these measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between Members to restrict international trade. Agreement recognises (Art. 2.2) that governments have the right to take SPS measures but that they should be applied only to the extent necessary to meet the objective, but not as disguised non-tariff barrier in trade between Members where identical or similar conditions prevail. Agreement calls for harmonizing SPS measures on as wide a basis as possible, by basing them on international standards, guidelines or recommendations, where they exist, except as otherwise provided for in this Agreement (Art. 3.1). It allows Members to maintain or introduce measures which result in higher levels of standards, if there is scientific justification or as a consequence of consistent risk decisions based on appropriate risk determinations made by a Member. In case of introduction of new standards, the governments are required to provide advance notice of new or changed SPS regulations, and establish a national enquiry point to provide information. The SPS provision on equivalence requires Members to accept the SPS measures of other Members as equivalent, even if these measures differ from their own or from those used by other Members trading in the same product, if the exporting Member objectively demonstrates to the importing Member that its measures achieve the importing Member's appropriate level of SPS protection. For this purpose, reasonable access shall be given, upon request, to the importing Member for inspection, testing and other relevant procedures. The SPS Agreement spells out procedures and criteria for the assessment of risk and the determination of appropriate levels of sanitary or phytosanitary protection. When international standards are followed, there is no chance for being legally challenged in a WTO dispute. Art 5.7 of the SPS Agreement allows temporary “precautionary” measures to deal with scientific uncertainty.

The international framework: Certification, Traceability, Segregation, Preserved identity and Labelling

The Codex Alimenarius Commission places stress on food labelling and one of its General Subject Committees has mandate on 'Food Labelling'. Food label is a most reliable, effective and ethical practice to communicate to the consumer about the product in terms of its identity, quality and safety. A food label normally declares the name of the food, its ingredients, proximate amount of specific ingredient(s) which are high lighted, prominent indication on durability/shelf life, special storage conditions, if any, name of manufacturer and distributor, the place of origin and the process used in manufacture in certain cases, and instructions for use. A label, backed by suitable consumer protection laws, safeguards consumer rights and immensely helps to check the unfair commercial practice. When certain essential products of consumers are not labelled, they exercise their choice largely on the basis of trust they have built over a period or on the reputation of the seller. Label is more useful to the consumer and seller when the merchandise in question is novel and unfamiliar. For the manufacturer, labelling is a powerful tool in marketing when used effectively and responsibly. Thus, labelling offers a win-win situation for consumer, seller and producer.

"Label" means any tag, brand, mark, pictorial or other descriptive matter, written, printed, stencilled, marked, embossed or impressed on, or attached to, a *container* of *food*. "Labelling" includes any written, printed or graphic matter including a claim that is present on the label, which accompanies the food, or is displayed near the food, including that for the purpose of promoting its sale or disposal. "Food" includes processed, semi-processed or raw, and including drinks, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food". On the other hand, "Food Additive" is that substance, which is not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products becoming a component of or otherwise affecting the characteristics of such foods. The food additives are not "contaminants" or substances added to food for maintaining or improving nutritional qualities. "Claim" means any representation which states, suggests or implies that a food has particular qualities relating to its origin, nutritional properties, nature, processing, composition or any other quality. Food labelling, especially the claims made on the label is guided by the Interpretative Codex guidelines. These guidelines cover the nutrition and health claims, conditions for production, marketing and labeling of organic foods, and foods claimed to be "halal".

Food adulteration is a common undesirable trade practice in many countries threatening food safety. Food safety laws, including labelling, are directed to address this evil. Some of the examples of these regulations are: (1) Using inappropriate name in relation to the

composition of food, (2) Adulteration of high value food with cheaper visually undetectable ingredients, (3) Use of low value fillers for extending a food, (4) Incorrect labelling of the true origin of the food or ingredients, (5) Suppressing or misleading information on geographical or country of origin, (6) Incorrect description of suppression of information on a process or treatment given to the food, and (7) Incorrect quantitative declaration of components of a food. Thus, there are a number of areas that regulate labelling to protect consumer interest and health.

Label is used both in food and nonfood products. Consumer products (toys, detergents, electronic appliances, cosmetics, etc) require safety labelling (symbols and safety phrases, composition and environmental information). Then, the issue arises whether food and non-food products should have similar or different labelling pattern? If food labelling has to be different as a class, then there is need for providing certain commodity-wise general information as well as specific or detailed information on foods in the label. Providing label with more general information on different aspects is called horizontal lebelling or *lex generalis.* The provision of specific and more detailed information on the label on specific aspects such as composition/quality standards, etc is called vertical labeling or *lex specialis.* Consumers may also like to have certain labelling information mandatory and clearly distinguishable from optional and marketing information. Therefore, a legislation on labelling needs to address all these aspects and describe a minimum Standardized framework for presentation of label information.

General Mandatory Labelling Standards of Prepackaged Foods

The information essentially to be provided in the label of prepackaged food, according to Codex standard, includes name of the food, list of ingredients, net content and drained weight, name and address of the manufacturer, packer, distributor, importer, exporter or vendor, country of origin, lot identification, date marking (“Date of Manufacture”, “Date of Packaging” , “Sell-by-Date”, “Date of Minimum Durability”, “best before” , etc) and storage instruction, and instruction for use. Additional mandatory labelling may include quantitative labelling of ingredients to place special emphasis on the presence of one or more valuable and/or characterizing ingredients or on the low content of one or more ingredients, etc and to display prominently whether or not the food has been pre-treated with ionizing radiation or freezing. Irradiation treatment may be optionally indicated with international food irradiation symbol placed in close proximity to the name of the food. Other optional labelling information may include pictorial device written, printed, or graphic matter, provided that these are not in conflict with the specified mandatory requirements and those relating to claims. Commodities exempted from mandatory labeling with information on ingredients, lot number and instruction to use are spices and herbs, small units, where the largest surface area is less than 10 cm^2.

List of ingredients

A list of ingredients shall be declared on the label, except for single ingredient foods, which shall be headed or preceded by a title consisting of /including the term 'ingredient'. All ingredients shall be listed in descending order of ingoing weight (mg) at the time of the manufacture of the food. Where an ingredient is itself the product of two or more ingredients, such a compound ingredient may be declared, as such, in the list of ingredients, provided that it is immediately accompanied by a list, in brackets, of its ingredients in descending order of proportion. A compound ingredient, except food additives, need not be declared when it constitutes less than 5% of the food. All listed foods and ingredients known to cause hypersensitivity shall always be declared. Added water has to be declared as the ingredient except when it forms natural part of an ingredient in a compound food such as syrup. A food additive carried over into a food in a significant quantity or in an amount sufficient to perform a technological function in that food as a result of the use of raw materials or other ingredients in which the additive was used shall be included in the list of ingredients. The presence in any food or food ingredients obtained through biotechnology of an allergen transferred from any of the products shall be declared.

General Principles

Labels shall be applied in such a manner that they are not detachable from the container. All statements mandatory on the label in accordance with Codex standard shall be clear, prominent, indelible and readily legible by the consumer under normal conditions of purchase and use. When the container is covered by a wrapper, the wrapper shall carry the necessary information or the label on the container shall be readily legible through the outer wrapper or not obscured by it. The name and net contents of the food shall appear in a prominent position and in the same field of vision.

If the language on the original label is not sensible to the consumer for whom it is intended, a supplementary label containing the mandatory information in the required language may be used instead of re-labelling. When re-labelling or a supplementary label is used, the mandatory information provided in the original label shall be fully and accurately reflect in.

The Labelling of Food Additives

Food additive means any substance not normally consumed as a food by itself and not normally used as a typical ingredient of the food, whether or not it has nutritive value, the intentional addition of which to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food results, or may be reasonably expected to result, (directly or indirectly) in it or its by-products becoming a component of or otherwise affecting the characteristics of such foods,

but excluding contaminants, or substances added to food for maintaining or improving nutritional qualities, or sodium chloride.

In the context of food additives, it is important to distinguish them from food processing aids and contaminants. Contaminant means any substance not intentionally added to food, which is present in such food as a result of the production (including operations carried out in crop husbandry, animal husbandry and veterinary medicine), manufacture, processing, preparation, treatment, packing, packaging, transport or holding of such food or as a result of environmental contamination.

General Principles on labelling additives

Food additives should not be presented on any label in a manner to give false, misleading or deceptive or in a manner to create an erroneous impression regarding their character in any respect. Food additives should neither be described nor presented in any labelling by words, pictorial nor other devices in a manner that it might be confused, either directly or indirectly, with any other product. The labels of all food additives sold shall bear the prescribed information on details of food additive such as name(s), whether it is "natural", "nature-identical", "artificial", or their combination, instruction on keeping and use, net contents, name and address of the manufacturer, packer, distributor, importer, exporter or vendor, country of origin, and the identity of the producing factory and the lot. Irradiated food additives shall be so designated.

Labelling of and Claims for Prepackaged Foods for Special Dietary Uses

'Foods for special dietary uses' are those foods which are specially processed or formulated to satisfy particular dietary requirements which exist because of a particular physical or physiological condition and/or specific diseases and disorders and which are presented as such. The composition of these foodstuffs must differ significantly from the composition of ordinary foods of comparable nature, if such ordinary foods exist.

The General principle of labeling prepackaged foods for special dietary uses is that it shall not be described or presented in a manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding their character in any respect. The mandatory labeling of this group of foods shall bear the following information: (1) name of the food with designation such as "special dietary" or "special dietetic" food, together with the characterizing essential feature, but not the condition for which the food is intended, in appropriate descriptive terms in close proximity to the name of the food; (2) the list of ingredients; (3) nutrition labelling including available carbohydrate, fat and energy per unit quantity (100 g), protein content, and total quantity of those specific nutrients or other components per unit quantity which provide the characterizing essential feature for the special dietary use; (4) the net content and drained weight; (5) the name and address of the

manufacturer, packer, distributor, importer, exporter or vendor of the food; (6) the country of origin; (7) the lot identification; and (8) date marking and storage instructions for opened and unopened packages with warning if storage is not desirable for opened package.

Any claims made on this group of foods such as those intended for "special dietary use" shall be in accordance with the General Guidelines on Claims specified by the Codex Alimentarius Commission (CAC/GL 1-1979). A food that is not modified, but is suitable for use in a particular dietary regimen because of its natural composition, shall not be designated "special dietary" or "special dietetic". Claims such as the food is beneficial for the prevention, alleviation, treatment or cure of a disease, disorder or particular physiological condition are prohibited unless they are (a) in accordance with the provisions of Codex standards or guidelines for foods for special dietary uses, and follow the principles set forth in such standards or guidelines; or (b) in the absence of an applicable Codex standard or guideline, permitted under the laws of the country in which the food is distributed. If the foods for special dietary uses are irradiated, it shall be labelled in accordance with guidelines given above. Claims which are misleading or potentially misleading, such as those without meaning or incomplete comparatives and superlatives; and claims as to good hygienic practice, such as "wholesome", "healthful", "sound", are prohibited.

Guidelines on Nutrition Labelling

A separate guideline is developed for precise nutrition labelling to convey information of the nutrient content of a food including those for special dietary use and thereby facilitate the consumer to make informed choice of a food, and to encourage the use of sound nutrition principles in food formulations for the larger public health benefit. Nutrition labelling should not deliberately imply that a food which carries such labelling has necessarily any nutritional advantage over a food which is not so labelled.

The principles of nutrition labeling include nutrient declaration and supplementary nutrition information. The nutrient declaration should have standardized statement or that the nutrients present and considered to be of important are to be listed along with an indication of the quantity of such nutrients. Nutrition claim means a statement that a food has particular nutritional properties including but not limited to the energy value and to the content of protein, fat, carbohydrates, vitamins and minerals. A mere listing of ingredients as a mandatory requirement of nutrition labeling and quantitative or qualitative declaration of certain nutrients as a requirement under national legislation do not constitute nutrition claim.

A nutrient declaration should have the following mandatory information: energy value, amounts of protein, available carbohydrate (i.e., carbohydrate excluding dietary fibre) and fat, amount of any other nutrient as required by national legislation or national dietary guidelines. Where a specific nutrition or health claim is applied, then the declaration of the amount of any other nutrient considered relevant for maintaining a good nutritional status as required by national legislation or national dietary guidelines should be mandatory. Only vitamins and

minerals for which recommended intakes have been established and/or which are of nutritional importance in the country concerned should also be declared. Vitamins and minerals which are present in amounts less than 5% of the Nutrient Reference Value or of the officially recognized guidelines of the national authority having jurisdiction per 100 g or 100 ml or per serving as quantified on the label should not be declared. Where a product is subject to labelling requirements of a Codex standard, the provisions for nutrient declaration set out in that standard should take precedence.

The supplementary nutrition information may vary across countries and target groups within a country according to the needs of the target groups. This is intended to increase the consumer's understanding of the nutritional value of their food and to assist in interpreting the nutrient declaration. This should be optional and should only be given in addition to, and not substituting the nutrient declaration, except for target populations who have a high illiteracy rate and/or comparatively little knowledge of nutrition.

Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognised by generally accepted scientific review of the data and the scientific substantiation should be reviewed as new knowledge becomes available. Health claims should have a clear regulatory framework for qualifying and/or disqualifying conditions for eligibility to use the specific claim, including the ability of competent national authorities to prohibit claims made for foods that contain nutrients or constituents in amounts that increase the risk of disease or an adverse health-related condition. The health claim should not be made if it encourages or condones excessive consumption of any food or disparages good dietary practice. If appropriate, advice to vulnerable groups on how to use the food and to groups, if any, who need to avoid the food.

General Guidelines on "halal" claim in food labelling

Halal food means food permitted under the Islamic Law (lawful food) and fulfilling conditions that it does not consist of or contain anything which is considered to be unlawful according to Islamic Law, that has not been prepared, processed, transported or stored using any appliance or facility that was not free from anything unlawful according to Islamic Law and that has not in the course of preparation, processing, transportation or storage been in direct contact with any food, which is considered to be unlawful according to Islamic Law. However, production, processing and storage as well as transporting of halal and non-halal foods may be acceptable even if same premises or same transport facility are used, provided all necessary measures are taken to prevent any contact or mixing between these two types of foods. Lawful food means those foods of animal origin, which excludes products or derivatives of animals considered as unlawful. In the case of food of plant origin, lawful food shall exclude intoxicating and hazardous plants except where the toxin or hazard can be eliminated during processing. The food shall not include alcoholic drinks, food additives

derived from prohibited animals or plants. Slaughtering of animals shall also follow according to the procedure described under Islamic Law and in compliance with the rules laid down in the Codex Recommended Code of Hygienic Practice for Fresh Meat.

The CAC accepts that there may be minor differences in opinion in the interpretation of lawful and unlawful animals and in the slaughter act, according to the different Islamic Schools of Thought. As such, these general guidelines are subjected to the interpretation of the appropriate authorities of the importing countries. However, the certificates granted by the religious authorities of the exporting country should be accepted in principle by the importing country, except when the latter provides justification for other specific requirements.

Additional labeling requirements are that the word halal or equivalent terms should appear on the label and the claims on halal should not be used in ways which could give rise to doubt about the safety of similar food or claims that halal foods are nutritionally superior to, or healthier than, other foods.

GM Food and Labelling

With the advent of GM-crops, traders, processors and consumers are being posed with the problem of segregation, traceability and labeling GM foods to offer options to consumers. Introduction of GM-technology in crops such as grains, fruits or vegetables might pose situations for their consumption either as raw or cooked or processed products or food derived from animals/birds, which are raised on GM feed or other GM products. Processed products may originate either partially or totally from GM foods. Food processing industry also may have to exercise option for using GMO-derived flavoring agents and enzymes. The issue is whether such food should be compulsorily labeled to provide informed choice to the consumer and processor. One argument is that as most of the biotech foods that are placed on the market have been found to be "substantially (essentially) equivalent" to their conventional counterparts, and does not differ significantly in composition and therefore, labeling of biotech food for GM origin is unnecessary from this technical point of view. A GM food is deemed to be substantively equivalent to the conventional counterpart, if both are found to be *largely* similar. This similarity is determined on molecular and compositional analysis, amount of toxins and allergins, nutritional value and also in terms of its specific use and safety for the environment and for human and animal health. The counter argument is that the GM-food is an unfamiliar product where an informed choice is not feasible without appropriate labeling and hence denial of right to the consumer in exercising a choice against GM-food and therefore such denial raises legal or ethical issues.

Recognising the global free-choice-consumer-opinion on the GM food, there is a justified apprehension among GM food producers and processors that either an affirmative label or advertisement of GM-origin may adversely affect the consumer demand and therefore their business interests. However, producers are willing to label with positive consumption attributes of GM food, like better flavor, nutritional composition, etc. Despite assurances from

GMO producers and some governments about the safety of biotech foods on the market, many consumers insist on their right to distinguish GM-derived food and food products from conventional foods. European Union, which has taken some pro-active measures on GM food production, processing and marketing under label, offers some lessons to those who wish to offer free-choice to consumer and accede their right to distinguish. Two new rules concerning GMOs became legally binding in EU on 18 April 2004. One covered Traceability and Labelling of GMOs (EC No. 1830/2003). The other, the GM Food and Feed Regulation (EC No. 1829/2003), deals with authorisation procedures and labelling issues.

Under the food and feed regulation, labelling is essential for all food and feed products derived from GM sources, regardless of the presence of detectable novel genetic material in the final product and regardless of the quantity of intentionally used GM ingredient present. Such labelling rules apply at the sale point, for consumers exercising their choice on foods containing GM ingredients, such as soya oil, soya flour, corn starch or glucose syrup. Example of a GM fresh produce approved for consumption is sweet Bt-maize (Bt 11). Currently, only ingredients derived from specific varieties of GM soya, maize, oilseed rape and cotton are allowed for food in the EU. The GM Food and Feed Regulation also provides for a threshold for the adventitious, or accidental presence of GM material in non-GM food or feed sources. This threshold for food, additives and flavours is 0.9%, but only applies to GMOs that have an EU authorisation. It is zero tolerance for any GM variety that is not approved. So any GMOs which do not fall within the approved categories cannot be imported into the EU. The food manufacturers are made responsible to ensure that any foods or food ingredients imported are at designated threshold and the GM contamination is only from approved GM crop varieties.

The Food Labelling Regulations, 1966 make falsified description, advertisement or presentation of food an offence. European Marketing Standards and few other laws protect consumers against dishonest labelling and mis-description. The labelling standards for GM foods are different in different countries. In Denmark GM labelling is required not only when it can be proven scientifically but if it is possible that the food will contain GM material. In Japan, presence of GM material above 5 % requires labelling. In the USA GM foods are required to meet equivalent safety standards as the conventional foods, which mean that no labelling for GM foods is required solely because they are of GM origin. Pre-market permit and labelling is required only if it differs substantially from its conventional counterpart. These country to country variations expose the insufficiency of the risk data available on GM foods to arrive at consensus decision on risks and the level of arbitrariness in these decisions.

The Traceability of food from farm to fork

The *Ad Hoc* Intergovernmental Task Force on Foods Derived from Biotechnology constituted by the CAC recognised the importance of traceability/product tracing as a risk management tool of GMOs at all stages of food chain, from farm to market, as well as a

useful measure for the control and verification of labelling claims. It can help consumers for making informed choices to protect them against food-borne hazards and deceptive marketing practices and facilitate trade through precise product descriptions. This regulation demands business operators using or handling GM products to transmit and retain information at every stage of placing on the market. For example, where production starts with a GM crop, the company selling the crop for feed production would have to inform any buyer that it is GM. This information has to be retained for 5 years. This will enable products to be withdrawn from the market if any unexpected adverse effects were to arise.

In addition, it is desirable that food and beverage marketing firms augment their existing product traceability protocol by providing continuous visibility on its production and to provide positive assurance that *every* production unit adheres to its business rules. Such Positively Assured Traceability^{TM} (PAT) places the consumers at high confidence for exercising their choice of foods and help to buy according to their particular requirements and cost, be it for diet and health or personal taste and preferences. The essence of PAT is providing continuous visibility regarding: (i) the relevant attributes of each incoming shipment/production lot, (ii) the preserved identity of the material from each incoming shipment/production lot as it moves through an operation across various transformational and commingling steps, such that the attributes of the constituent components of each finished goods are known; and (iii) comparison of data from Steps (i) and (ii) with the firm's operational and quality business rules. This may substantially help a firm in defending any unjustified public or media complaint on the product and recall decisions.

The Food Standards Agency's role is to prevent mislabelling or misdescription of foods. Mislabelling when deliberately done constitutes a crime of fraud. The Codex standards specify that the traceability tool "should not be more trade restrictive than necessary" and should be practical, technically feasible and economically viable. The *Ad Hoc* Intergovernmental Task Force on Foods Derived from Biotechnology recognised the importance of traceability/product segregation as a tool to manage risk and a useful measure to control and verify labelling claims.

Segregation and ID preservation of GM- and non-GM crops/products all along the food chain may add substantive overhead cost, which may finally end up in consumer paying higher prices for segregated and ID preserved foods. While deployment of contract farming or production at larger farms may minimise intermixing between GM- and non-GM produces at production level and also cut the cost on segregation and ID preservation, it is challenging and virtually impracticable in countries with small farm holdings and many such farms growing both GM- and non-GM crops. However, price premiums to either the GM- or non-GM foods may largely help in neutralizing the extra cost incurred on segregation and ID preservation. In this context, use of specific ID markers in GM- or non-GM crops as well as in their products may facilitate easy detection from farm to market, within legally allowed tolerance level.

Segregation, ID preservation of GM-produce is difficult not only under small farmer production systems, but also with small and medium sized enterprises (SMEs). On reasons of cost and infrastructure, it is difficult to track the GM-product traceability with database on transactions across the food chain. It becomes more complex in developing and least developing countries, where production is undertaken in many small farms, markets are not organized to preserve identity and traceability, and forward trading and transportation from local markets are equally unorganized. Under such situation, a credible non-GM label may be very seriously compromised. More over, in the case of perishable produces/commodities, such segregation and ID preservation becomes extremely difficult. These limitations and failures may erode credibility of GM-labelling and consumer trust on the system. Notwithstanding these limitations, consistent enforcement of standards, testing, and certification would decrease transaction costs and increase market efficiency in segregation and ID preservation. Tolerance levels for GM-mixing are guided by the level of risk, consumer preference, the carrying capacity of the national system to segregate GM crops from non-GM and ready availability of low cost testing services.

Interestingly when several GM-crops hit and flood the market with poor ID preservation, the non-GM crops may command specific market demand at premium prices, if there are large non-GM preference consumers. This may offer an opportunity to preserve the ID of non-GM crop and market them on a premium akin to the current market for organic products. Such scenario may promote standards, testing, certification, and enforcement for non-biotech foods as well as promoting accreditation of private labs for the testing service. Ultimately, the credibility of GM labelling heavily depends on consistency achievable in standards, IP enforcement, testing services and its quality, certification services and enforcement of all aspects of the law. Many food manufacturers and traders depend on these services and enforcement at every level to ensure credible labelling. It is also important that social/public benefits of credible label shall be outweighing the cost so as to become sustainable.

Packaging, marking and labelling requirements of industrial and agricultural products including food are also regulated by the Agreement on Technical Barriers to Trade under the WTO. The Agreement on TBT seeks to ensure that technical negotiations and standards, as well as testing and certification procedures, do not create unnecessary obstacles to trade. Technical regulations shall not be more trade-restrictive than necessary to fulfil a legitimate objective, taking account of the risks non-fulfilment would create. Such legitimate objectives are, *inter alia*, national security requirements; the prevention of deceptive practices; safety of human/animal/plant health, or the environment. Where relevant international standards are readily or immediately available, Member countries shall use them, or the relevant parts of them, as a basis for their technical regulations. However, the agreement recognizes that countries have the right to establish protection, at levels they consider appropriate, of human, animal or plant life or health or the environment, and shall not be prevented from taking measures at justifiably determined levels of protection.

The international framework: Examples of biosafety legislation and its regional harmonisation

Biosafety laws and regulations concern the food, feed, health of humans, animals and plants and the environment. These laws and regulations are both international and national in nature with regional integration in few groups of countries. Harmonisation of these legislations becomes relevant at international, national and regional levels. Although since long time the CAC, the OIE and the IPPC are concerned with setting standards, guidelines and recommendations on food safety, animal health and zoonoses, and on plant health, respectively, the emergence of WTO demanded substantial harmonization, both horizontal and vertical, among these international biosafety instruments vis-à-vis WTO. Similarly, in the case of the Cartagena Protocol on Biosafety, the processes involving Advance Informed Agreement (AIA), particularly the risk analysis, are being enforced with considerable variation by countries under their national laws and regulations. Conflict potential exists between the Cartagena Protocol on Biosafety and some of the internationally enforceable WTO Agreements, in particular, the SPS Agreement and the TBT Agreement with respect to trade in GMOs.

Developing countries, countries in transition and least developed countries face difficulties in conducting risk-analysis in relation to GMOs. This risk analysis may call for international standard-setting and harmonization. Such harmonization is an integral part of existing pest and phytosanitary risk analysis programmes, and of risk analysis in relation to human health sanitary measures, as signalled in the WTO Agreements on SPS and TBT. Within the WTO, biosafety in relation to GMOs appears to fall chiefly under the SPS Agreement. This Agreement concerns sanitary and phytosanitary measures:

(a) to protect animal or plant life or health from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;

(b) to protect human or animal life or health from risks arising from additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs;

(c) to protect human life or health risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests; or

(d) to prevent or limit other damage from the entry, establishment or spread of pests.

The SPS Agreement recognizes specific international standards, guidelines and recommendations set by the CAC relating to food additives, veterinary drug and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice; by the OIE relating to animal health and zoonoses; by the IPPC relating to plant health; and by the other relevant international organizations open for membership to all Members, as identified by the Committee relating to matters not covered by the above organizations. The TBT Agreement covers a large number of technical measures that seek to protect consumers from economic fraud and deception and measures concerning human, animal and plant life and health not covered by the SPS Agreement, and the environment.

Codex Alimentarius provisions concerning quality and compositional requirements, labelling, nutrition and methods of analysis are relevant to the TBT Agreement.

With respect to a legal framework on biosafety, the harmonization process may work at different levels, within a country, across countries and even groups of countries at regional level. The harmonization is always with reference to an over riding international agreement or convention to which countries have joined party with binding for compliance. At country level, there could state-specific laws enacted by the national legislative body of a country's government, national regulations, which are subordinate legislation of administrative nature authorized by the national law and national guidelines, which are intended to assist by providing ways of complying with national laws and regulations. At the inter-country level there could be bilateral or multilateral agreement, which deals with transactions under the respective national laws, regulations and guidelines. This could accrete into a regional agreement as well. For example, among the eight countries who are members of the South Asia Association for Regional Cooperation (SAARC), biosafety protocols, either as executive order or legislation, are in place in Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Although all these regulations or laws are in compliance with CPB, they differ in administrative details and public involvement in decision making process. For example, while Bangladesh classifies the risks into four categories, Pakistan does this in three. The huge difference among countries in implementing the biosafety is a matter of concern.

India is currently revamping its regulations on protocol and GMO administration. Recently India initiated an integrated, science-based, competent and transparent system for biosafety regulation under an autonomous agency called National Biosafety Regulatory Authority (NBRA). A draft legislation to establish this system is currently before the Indian Parliament. An initiative is also made by the ten countries under Association of South East Asian Nations (ASEAN) to harmonise their legislation for products derived from modern biotechnology and intellectual property rights, R&D in biotechnology and related environmental protection. Asian Bio Net, an official web site of FAO in this region is assisting Asia in capacity building in the biosafety of GM crops. Regional harmonization and cooperation offers opportunity for sharing of risk-assessment methodologies and results between developing countries with similar ecological environments, as suggested by the Nuffield Council of Bioethics.

The evolution of IPPC over years provides as a good example of harmonization of an international convention. IPPC more recently harmonized with the SPS and TBT Agreements of the WTO. The first text of the IPPC drafted in 1929 underwent revision and was adopted at the FAO Conference in 1951. The Convention came into force in 1952. In 1979, the IPPC was amended and the revised text of the Convention came into force in 1991. Soon after, with the conclusion of the Uruguay Round of trade negotiations and arrival of the SPS Agreement under WTO, the international regulatory landscape on plant protection changed substantially. The leveraging of important technical and legal role to the IPPC by the SPS Agreement

necessitated the IPPC to harmonize its framework in sync with the SPS Agreement for evolving elaborate international standards and to ensure that phytosanitary measures are fairly used in trade. The FAO, in response to this, established a Secretariat for the IPPC in 1992, followed by the formation of the Committee of Experts on Phytosanitary Measures (CEPM) in 1993. The IPPC Secretariat immediately began a major program of standard setting with concurrent amendment of the Convention to more accurately reflect its enhanced role, particularly in harmony with the SPS Agreement. The amended Convention was concluded in November, 1997 and the revised text of the IPPC was approved. It emphasizes cooperation and the exchange of information toward the objective of global harmonization. In addition to describing national plant protection responsibilities, it also addresses important elements of international cooperation for the protection of plant health and the establishment and use of International Standards for Phytosanitary Measures (ISPMs). The revised IPPC entered into force in October 2005.

At national level, the biosafety regulatory frameworks vary according to national priorities and statutory structures. In addition, the different social conditions that prevail in countries make it difficult to typecast the appropriate regulatory systems that should be enforced by developing countries. Notwithstanding such variation, a number of elements are essential and constitute the core of many regulatory frameworks. These are national policy and strategy; regulatory framework consisting of regulations and guidelines; mechanism for handling applications and issuing permits (including risk assessment and management); monitoring and enforcement measures and systems for information dissemination. The regulatory processes involve pre-approval risk assessment evaluation and post approval risk management practices with the requisite monitoring and enforcement measures usually indicated in the conditions of the permit.

Although agreement has been reached on the scientific principles of environmental risk and food safety assessment, consensus has not been achieved on the extent of data required to comply with these principles or on the role of the data for decision-making. A running dispute on the "science" underlying the risk analysis and related restrictions on GMO has been raging between USA and EU for long. This apart, the harmonization process is handicapped, particularly in developing and least developed countries due to lack of resources including local expertise. In order to make informed decisions on the safety of GMOs, governments of these countries need substantial human and institutional resources in the disciplines required for the assessment of risks to the environment and for human food. The role of regional cooperative measures in drawing on a wider resource base in handling risk assessment and management issues has also been a subject of several dialogues. These countries have limited expertise in the required fields of science, as the small number of biotechnologists in these countries is generally engaged in research and therefore mostly unavailable to the regulatory bodies and as policy-makers. In many developing countries, the same scientists who conduct biotechnology research, sit on decision making bodies, and also involved in both risk

assessment and risk management related decision-making. There are three vulnerabilities in this scenario: (a) when developers are also risk assessors, the potential for conflict of interest is magnified; (b) because most members of the decision making bodies are recruited on a voluntary basis, they do not devote much time to this responsibility; (c) because membership of the decision making bodies including the scientific advisory groups generally rotates, there is no continuity in the capacity gained through experience. This, therefore calls for more capacity building for scientists in the regulatory agencies to take a more prominent role in the regulation of modern biotechnology activities.

Building capacity of developing, least developed and transition counties in developing and managing biosafety is hence an important priority area for a few international organization such ad GEF, UNDP, UNEP and FAO. For example in Africa, while South Africa was the first and only country to develop GMO regulations with its own funding (its GMO Act came into force in 1997), national biosafety frameworks (NBFs) of ten African countries (Cameroon, Egypt, Kenya, Malawi, Mauritania, Mauritius, Namibia, Tunisia, Uganda, and Zambia) were developed between 1997 and 2000 only with financial assistance from the Global Environmental Facility (GEF) and project implementation support from the U.N. Environmental Program (UNEP). Since 1998 Zimbabwe was another country which established an independently developed GMO regulation, although this was later made consistent with the provisions of the Cartagena Protocol on Biosafety with GEF assistance. GEF also assisted another 38 African countries (Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, CAR, Cape Verde, Congo, Comoros, DR Congo, Djibouti, Ethiopia, Eritrea, Gabon, Gambia, Ghana, Guinea Bissau, Ivory Coast, Lesotho, Libya, Liberia, Madagascar, Mali, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania and Togo) to develop their NBFs with project implementation support from UNEP. This programme of GEF has so far assisted 139 countries from Asia, Africa, Latin America, and Central & Eastern Europe to prepare their NBFs to facilitate the entry into force of the Cartagena Protocol on Biosafety. As of 27 October 2008, more than 106 countries, including Bangladesh, have completed development of their National Biosafety Projects and their draft NBFs.

On harmonization of Law on Safety in Biotechnology across countries, an African nationalist viewpoint argues for a pan Africa Model, with space for individual African governments to adopt its own national biosafety regulations while adhering to a broader and unified continental biosafety framework that leverages the discretionary components provided in the Cartagena Protocol on Biosafety. This would allow countries to adopt more protective measures than the agreed minimum set out in the Protocol. The Model law is far more comprehensive than that is required by the Biosafety Protocol, it recognizes the importance of Africa as both a centre of origin and a centre of diversity with regard to food and other crops, the precautionary principle and the sovereign right of every country for conducting rigorous risk assessment of any GMO before any decision regarding its use is made. It seeks to

incorporate a liability and redress regime and stricter controls including AIA procedure, notification provision and prior informed consent for the introduction and use of GM food as food aid. The 74th Ordinary Session of the OAU Council of Ministers held in Lusaka in July 2001 had endorsed a Model law, although it has not been made legally binding to Members. The Model Law applies to the import, export, transit, contained use, release and placing on the market of any GMO and a product of a GMO, whether it is intended for release into the environment, for use as a pharmaceutical, for food, feed or processing.

The need for harmonisation of biosafety protocols is not only an issue for developing, least developed and transition countries, but also one for the developed countries. For instance, different strategies for analysing specific risk categories are followed across Europe. Hence, an action to co-ordinate, harmonise and exchange of biosecurity practices, particularly safety assurance (risk containment - risk assessment applicable to BSL3 and 4 laboratories) criteria within a pan European network was initiated recently. This created a pan European network of biosafety experts and a consortium website including an updateable inventory of biosafety relevant elements. It also assesses the cost-effectiveness of measures and methods designed to ensure the safety of the public and private research infrastructures, compile all information into a report and undertakes a program for training and seminars involving national and international organizations in the field of biosafety.

Cardinal area of biosafety regulations is the precautionary approach and risk based analysis and science based approach in risk analysis, identification, management and monitoring. The “science” underlying the risk analysis and related restrictions on GMO trade have been embroiled in two decade long dispute between the US and EU. There are unsettled grey areas between them in standards and burdens of proof, attitudes to uncertainty, and the legitimacy of the “precautionary approach and risk based analysis”. In the on-going discourse, developing and least developed countries are thrown into a quagmire on the merits of the concepts of the “precautionary principle” and the “risk based’ approach to regulation based on a priori scientific proof of likelihood of harm. There is also geographical dispersion to styles of risk management and regulation, as much as there is geography to the scientific practices of risk assessment. Given current divergence in national and international approaches to biosafety, there is wider appreciation for fair harmonization of biosafety laws. It also raises a concern that some countries are coming under pressure to harmonize their laws with one school of regulatory regime. It mentions, for example, that powerful states have been pressuring a number of developing and transition countries, including Bolivia, China, Croatia, Ethiopia, and Sri Lanka, not to implement stringent regulations on GMOs. Caution is also conveyed that ‘harmonisation of biosafety regulation’ is designed to create a one-stop GMO approval system at the sub-regional level, so as to side step a country-by-country, case-by-case risk assessment and decision-making process. In this way, fast-track GM approval systems can be created for the expeditious introduction of GMOs. In this context, it is important that developing, least developed and transition countries are not put to pressure to

deny them the flexibilities available in the protocol on implementing stringent need-based regulations on GMOs which are pivotal from the point of their unique ecological, biodiversity, socio-cultural and farming practices.

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Chapter 6: Status of Relevant Laws and Regulations on Biotechnology in Bangladesh

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Introduction

Currently there are no special laws regulating biotechnology and biosafety in Bangladesh even though the country ratified the Cartagena Protocol on Biosafety on 5 February, 2004. This report attempts to review the status of laws and regulations that are relevant to biotechnology and biosafety issues in Bangladesh. These laws broadly fall under three distinct areas: Sanitary and Phytosanitary (SPS) Measures, Food Safety and Intellectual Property Rights (IPR). In addition to making a separate law on biosafety, this paper recommends that relevant laws and regulations should also be updated in order to develop a comprehensive legal framework for biotechnology and biosafety in Bangladesh bearing in mind its international obligations under the relevant treaties. SPS related laws would ensure that handling, transfer, export and import of genetically modified products do not cause any threat to human beings, plants and the environment. Food safety related laws would ensure that food made of genetically modified organisms do not also pose threat to the consumers. IPR related laws, if amended, would give legal protection to biotechnological research and inventions. Following paragraphs review the current legal status of laws and regulations on these three related areas in Bangladesh.

Biotechnology and relevant laws and regulations on sanitary and phytosanitary (SPS) measures in Bangladesh

Currently we have the following laws on SPS in Bangladesh: On Plant and Plant Products: Destructive Insects and Pests Act, 1914; Destructive Insects and Pests Rules, 1966. On Seeds: Seeds Ordinance, 1977, Seeds Rules, 1988. On Fish and Fish Products: Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983; Fish and Fish Products Rules, 1997. On Animal and Animal Products: Animal and Animal Product Quarantine Act, 2005. On Food: Pure Food Ordinance, 1959, Pure Food Rules, 1968.

The laws on destructive insects and pests regulate the quarantine measures for exported and imported plant and plant products. Rule 3 makes import permits mandatory. Under rule 4 an import permit may be granted with certain conditions. Imposition of conditions on import may help reduce the adverse impacts of releasing biotechnological products, such as the

potential impact of Genetically Modified (GM) plants on the environment, biodiversity and human health.

Under rule 8(1) a phytosanitary certificate from the country of origin is required. Additional information may be required for GM plant or in order to reduce the risks of adverse impacts of biotechnological inventions on environment and human health.

Under Rule 8(6), plants and plant products imported under a valid import permit but without phytosanitary certificate shall either be released after the necessary fumigation or treatment, or returned to the shipper or confiscated and destroyed at the expense of the consignee. These provisions may be used to prohibit unauthorised transboundary movements of GM plants or plant products. The above quarantine measures have been designed to reduce the threats that might arise from the introduction of foreign pests with the imported plant and plant products.

Seed related laws regulate the quality of certain seeds to be made available for sale in Bangladesh. The definition of 'seeds' given under section 2(j), as amended by the 1997 (Amendment) Act, is wide enough to include GM seeds. Section 3 of the Ordinance establishes the National Seed Board. The major functions of the Board, described in Rule 3, are: to advise the government to notify any kind or variety of seeds for regulation; to advise the government to withdraw or denotify outdated varieties of seeds; and to advise the government on a seed security system, among other functions. Section 8 of the Ordinance also establishes a Seed Certification Agency. The major functions of the Agency, described in Rule 6, are: to certify seed of any notified kinds or varieties; to certify seed of other registered varieties; to inspect fields to ensure that the minimum standards for isolation, rouging etc are maintained; and to ensure that seed borne diseases are not present in the field beyond the prescribed limit, among other functions.

Section 7 of the Ordinance prohibits the sale of notified seeds unless (a) such kind or variety of seed and the Seed Dealer is registered with the Board (b) such seed is identifiable as its kind or variety (c) such seed conforms to the standards of seed quality and the container of such seed bears, in the prescribed manner, the mark or label containing the correct particulars thereof.

These laws may be used to set up standards for GM seeds and to regulate their sale through notification in Bangladesh. These laws do not make any distinction between GM seeds and non-GM seeds. Therefore, these laws apply equally to GM seeds of a notified variety in Bangladesh. Furthermore, there is no provision that requires special measures to reduce the threats arising form use, handling or transfer of GM seeds.

The Animal and Animal Product Quarantine Act 2005 regulates the import and export of animal and animal products with a view to controlling the spread of animal diseases and protecting public health. Under section 3 of the Act, animal or animal products that might be the cause of animal or human disease, could be subjected to quarantine or their import or export could be prohibited or restricted, or otherwise regulated by imposing conditions in the

Import or Export Policy Order, passed from time to time by the Government, under the Imports and Exports (Control) Act, 1950.

Section 12 regulates the export of animal and animal products while section 13 regulates the import of animal and animal products. A licence is required for the import of animal and animal products and a health certificate is needed from the country of import. Under section 10, animal and animal products that are found to be infected with disease may be forfeited. This law could be used to prohibit or restrict the import or export of GM animal species or products that have adverse impacts on environment, biodiversity or human health. Necessary rules may be made under section 24 of the Act to regulate the import and export of GM animal species.

Fish and Fish Products (Inspection and Quality Control) Ordinance 1983 and Fish and Fish Products (Inspection and Quality Control) Rules, 1997. These laws deal with inspection and quality control of fish and fish products intended for exports from Bangladesh. Under section 5 of the Ordinance no person is allowed to export, sell for export or have in his possession for export, or deal in any fish or fish products intended for human consumption which is decomposed, unwholesome or contaminated with pathogenic organisms. This provision may be used to prohibit dealings with GM fish or fish products that might pose a threat to environment or human health.

The 1997 Rules regulate the major activities from the production to marketing of fish and fish products with a view to maintaining their export quality. Under Rule 14, a licence is needed for processing, exporting, and servicing factories. Under Rule 5, a licence will not be issued for supply to internal market, for sale, or processing for the purpose of export on the international market unless the quality assurance programme (QAP) stated in Schedule 9 to the Rules is followed. These provisions may be used to reduce the threats that might arise form the use, handling and transfer of GM fish and fish products.

At present there is no quarantine law for fish and fish products imported into Bangladesh. As a result, GM fish and fish products having adverse impacts on environment or other fish species or human health might enter into Bangladesh without any restriction. Furthermore, there is no law to regulate breeding, or crossbreeding activities in local firms. As a result, GM fish with adverse impacts might be developed locally for commercial purposes without any restriction. These laws do not regulate research, production, contained use nor the direct release of GM fish or fish products that might pose threat to environment, biodiversity and human health.

The challenges associated with implementation of the SPS laws in Bangladesh are numerous, including primarily inadequate resources and a lack of scientific equipment and modern laboratories.

Weak enforcement or no enforcement at all is another reason for poor sanitary and phytosanitary regulation in Bangladesh. The required administrative power to enforce the SPS laws is inadequate and ineffective. Thus, it is important to take steps to strengthen

administrative enforcement mechanisms. In addition, lodging complaints and litigation in this area is complex and subject to cumbersome procedures. The relevant Department such as,

Plant Protection Wing, has to go through a number of Ministries or Departments to file a claim against the violators of SPS laws.

Biotechnology and relevant laws and regulations on food safety in Bangladesh

Currently, the following laws are in place in Bangladesh:

- on Food Safety: Pure Food Ordinance, 1959; Pure Food Rules, 1967; and
- on Food Standards: Bangladesh Standards and Testing Institution (BSTI) Ordinance, 1985 and Bangladesh Standards and Testing Institution (BSTI) Rules, 1989.

These laws provide for better control and regulation of the manufacture and sale of food for human consumption. According to Section 3(5) of the Food Ordinance, 'food' means 'any kind of edible oil, fish, fruit, meat, or vegetable or any other article used as food…. and those articles which will be notified by the Government from time to time,…'. Thus, the definition is wide enough to include GM foods.

Section 4A establishes a National Food Safety Advisory Council to advise the Government on matters related to the safety of food, food standards and quality control as well as policies and strategies, all with a view to ensuring the purity, safety and proper nutritional value of food. This power can be used to ensure the safety of GM foods and to set up standards and quality control measures for GM foods.

Section 18 prohibits the use of false labels. It says, 'no person shall…give to the purchaser a label, whether attached to or printed on the container…which falsely describes that article or is otherwise calculated to mislead as to its nature, substance or quality'. Section 19 prohibits the false advertisements of food articles. It says, 'no person shall publish...an advertisement which falsely describes any article of food or is otherwise calculated to mislead the public as to its nature, substance or quality'. This provision may be used to require special labelling for GM food or food products.

These laws do not make any distinction between GM food and non-GM food. They do not require special measures for GM food and food products in order to protect public health.

The BSTI Ordinance provides for the establishment of an institution for standardisation, testing, metrology, quality control, grading and marking of goods. Section 3 of the Ordinance empowers the Government to establish the Bangladesh Standards and Testing Institution (BSTI). The major functions of the Institute, described in section 5, are, among others, to set up Bangladesh Standards of quality and dimensions relating to materials, commodities, structures, practices and operations; to secure compliance with the Bangladesh Standards; to implement Bangladesh Standards through the administration of a national certification mark

scheme or inspection of goods, or both; to grant, renew, reject, suspend, or cancel a licence for the use of Standard Mark etc.

BSTI adopts international standards such as standards developed by ISO, IEC, Codex. BSTI is the Codex focal point for Bangladesh. BSTI also develops its own standard where there is no Codex standard. If, for a given product Codex standard is not available and BSTI does not have its own standard, it then looks for countries where such product is available with the corresponding standard. In developing new standards BSTI follows the procedure of standard developments as laid down by ISO.

BSTI is mostly concerned with finished products and setting standards for these products. Food safety for raw products is the concern of the Department of Heath and the Local Government. They have their own inspectors to enforce laws. Obviously, there is no coordination between the activities of these departments and the BSTI.

In addition to standard setting BSTI is also responsible for certifying products manufactured either for domestic consumption or for export. According to current practice, for all food products certification is not needed, certification is compulsory for only 52 items, the list of which is available on their website. For other goods certification by BSTI is merely optional.

BSTI plays important role in the enforcement of BSTI laws. It is also empowered to take action under Pure Food Ordinance. It has inspectors, but the number is very limited as are its resources. It has its own laboratory. It makes arrangement for a mobile court to inspect market places to try summarily the offenders of BSTI laws and Pure Food Ordinance.

The Directorate General of Food under the Ministry of Food is only responsible to ensure the quality of food grain exported by the Directorate itself. It has its own testing laboratory. In case of food exported by it, it follows the standard mentioned in the contract. Where food is received as aid from other countries the Directorate follows Codex or BSTI standards. It has its own officials at Chittagong and Khulna sea ports who make necessary onsite inspections and investigations regarding the quality food.

Under section 23 of the Ordinance, the Government may, subject to certain conditions, prohibit, restrict, or control the taking out of Bangladesh, articles of any specified description, which do not bear the Standard Mark or regulate generally all practices including trade practices and procedures connected with the export of such articles. Under section 24 the Government may, by notification in the official Gazette, prohibit the sale and distribution of any article specified therein which does not conform to the relevant Bangladesh Standard. These powers may be used to set up Bangladesh standards for GM goods and to control their export, sale and distribution.

The challenges relating to implementation of food safety laws include the multitude of Ministries and Departments that enjoy overlapping jurisdictions, and a lack of coordination among them. The Ministry of Health, Ministry of Industries, Ministry of Local Government

etc are all involved in supervising and administering food safety related activities in Bangladesh. No single organization exists to oversee or coordinate food safety activities.

Poor enforcement of food safety related laws and regulations is another significant problem in Bangladesh. Foods are sold in open markets and on streets. As a result it is difficult to monitor or even enforce food safety laws given the fact that the Government gives priority to other important issues such as, security, crime prevention etc. Recently, mobile courts were organized by the Government to bring provide greater regulation and control of food safety and food quality in Bangladesh.

Biotechnology and relevant laws and regulations on intellectual property rights in Bangladesh

The following laws are in place in Bangladesh on intellectual property rights (IPR):

- Laws on Patents/Designs: Patents and Designs Act, 1911; and
- Patents and Designs Rules, 1933 (a new draft Patents and Designs Act is under formulation by the Department of Patents and Designs);
- Trade Marks Act, 2009 replacing the Trade Marks Act, 1940 and the Trade Marks Rules, 1963;
- Copyright Act, 2000 as amended in 2005.

IPR laws were enacted during the British rule in this sub-continent and thus, Bangladesh inherited its IPR laws from this period which served the purposes of trade and business of that time. Although certain amendments were made subsequently, they do not fulfil the needs of the present day. These laws are inadequate at least in two ways: firstly, they do not fulfil the requirements of the Trade Related Aspects of Intellectual Property Rights (TRIPs); and secondly, they do not provide an adequate legal framework for the promotion of biotechnological research and investment in the country.

The importance of IPR laws is gaining ground in Bangladesh as a result of its increasing participation in WTO and the need to protect its trade interests. Furthermore, the potential role of biotechnology in increasing the country's agricultural production and fulfil the ever-growing food needs of the people, is another reason why IPR laws need renewed attention.

Although IPR laws can take different forms (Patent, Design, Trademark, Copyright), in order to strengthen the legal framework for biotechnology in Bangladesh, a revision of the law of patents seems to be important. Currently, two separate Departments administer the IPR laws in Bangladesh. The Department of Patents, Designs and Trademarks is responsible for regulating aspects relating to patents, designs and trademarks and is headed by a Registrar. On the other hand, the Office of Copyrights, also headed by a Registrar, administers matters relating to copyrights in Bangladesh.

The Patents and Designs Act, 1911 and the Patents and Designs Rules, 1933 are the main laws on patents and designs in Bangladesh. These laws lay down the rules and procedures for

patents and designs in Bangladesh. Section 2(11) of the Act defines 'patent' as 'a patent granted under the provisions of this Act'. In view of the scope of TRIPS, this definition may be reformulated. Under section 3 an application in the prescribed form is required by the applicant expressing the desire to get a patent with declaration claiming to be the true and first inventor. The application must be accompanied by specification information and a fee. The conditions that need to be fulfilled to get a patent for an invention, are: novelty, non-obviousness (inventive step) and utility (industrial application). Under section 6, the Registrar is required to advertise the acceptance of the application. However, the applicant shall have the privileges and rights as if the patent had been sealed on the date of the acceptance of the application (section 7). Any person (within four months from the date of the advertisement of the acceptance of an application) may give notice of opposition to patent on certain specified grounds for example, that the invention is publicly used (section 9).

A patent confers on the patentee the exclusive privilege of making, selling, and using the invention throughout Bangladesh and of authorizing others to do so (section 12).

Under section 14, the duration of protection is 16 years but under section 15 it may be extended for another 5 to 10 years. This provision contradicts the provision of TRIPS as TRIPS provides for a minimum 20 years protection.

According to section 21, a patent has the like effect as against the Government as it has against any person. Under section 21A an inventor of munitions of war may assign to the Government all the benefits of the invention.

Section 22 provides for a compulsory licensing system. Any person interested in a patent may thus make a petition alleging that the demand for the patented article in Bangladesh is not being met to an adequate extent and therefore request the grant of a compulsory license. The government may either dispose such petition or refer it to the High Court Division.

Under section 26 revocation of a patent is possible in a suit before High Court Division on grounds such as fraud. Under section 29, a suit for infringement of patents may be filed in the Court of District Judge that has jurisdiction. The court is allowed to grant relief including temporary injunctions and damages. However, a person may be exempted for innocent infringement (section 30). The court may take the help of an expert in infringement cases (section 35).

Under section 65 the Registrar is given quasi-judicial power. In any proceedings under this Act he or she will have the powers of a civil court for the purpose of receiving evidence, administering oaths, enforcing the attendance of witnesses, compelling the discovery and production of documents, issuing commission for examining witnesses. The Registrar can also award costs and such awards shall be executable in any court having jurisdiction as if it were a decree of that court. The Registrar may however refuse to grant a patent for an invention if the use is contrary to law or morality (section 69).

Appeals against the decisions of the Registrar shall be made within 3 months of the date of the order (section 70). In addition to filing a civil suit under the Patents and Designs Act,

1911, a criminal case may be filed for the infringement of a patent on certain grounds described in the Penal Code, 1860, for example, counterfeiting products and trademarks.

The IPR laws do not comply with the requirements of TRIPS. For example the emphasis in Bangladesh law is on the patenting of processes but TRIPS requires patents for both processes and products. While Bangladesh patent legislation provides protection for 16 years, TRIPS requires protection for 20 years.

Furthermore, TRIPS allows exemption from patent on many grounds such as, plants, animals on grounds of protection to the health of animal, human beings, on the need for environmental protection etc. But under Bangladesh law these grounds of exemptions are not available.

The issue of parallel importation needs to be addressed. Current laws do not address this issue.

A significant problem with the IPR laws is that enforcement is very weak: litigation is very costly, time consuming and the damages and punishment provided is not adequate. The Department of Patents, Designs and Trademarks does not have adequate resources nor the technological support to administer the IPR related laws effectively.

A lack of awareness of the importance of IPR laws and the need to protect the rights granted by such laws is another reason why people infringe IPR laws. Therefore, relevant Departments must have adequate resources and training facilities for public awareness and capacity building in Bangladesh.

A draft law on Patents and Designs has been prepared. It aims to comply with the requirements of TRIPS and is under formulation by the Department of Patents and Designs. However, one of the outcomes of this project could be to make necessary recommendations so as to ensure that biotechnological inventions are properly protected by IPR laws.

As TRIPS allows for the legal protection of plant variety a law has been drafted on Plant Variety Protection. It contains provisions on farmer's rights in Bangladesh. But the enforcement aspect of the draft law is very weak and needs reconsideration. It does not disclose what will constitute an infringement of the Act, what remedies are available, which court has the competence to hear these cases, nor the powers of such court or the procedures to be followed.

The preceding discussion reveals the followings facts. Firstly, the laws and regulations reviewed in this paper are generally quite old. Secondly, the laws under review were not adopted specifically to address the possible threats of GMOs/LMOs. Thirdly, while some of the provisions of the laws under review might be relevant, the respective scopes of the laws are nevertheless limited. They do not provide a comprehensive regulatory regime for biosafety in Bangladesh. For example, the Destructive Insects and Pests Act, 1914 and the Destructive Insects and Pests Rules, 1966 regulate only import, export and transit of plant and plant products. They do not regulate use, transfer, handling, contained use, direct release etc

of plant and plant products which could be GM plant or plant products. Lastly, many institutions have overlapping jurisdictions which creates confusion and delay in the regulation of GMOs/LMOs. For example, the Seeds Ordinance, 1977 and the Seeds Rules, 1988 regulate the quality, sale and distribution of seeds in Bangladesh and is implemented by the Seeds Wing of the _____. But in order to import seeds, further permission is needed from the Plant Protection Wing to ensure that such seeds are pest free. If such seeds are used as foods than other institutions, for example, Department of Food and BSTI will have a role. This lack of coordination and lack of delineated competences may cause problems in the regulations of for example, GM seeds and any potentially adverse impacts on environment, biodiversity and human health.

The only relevant document currently in place to address biotechnology and biosafety aspects is the Biosafety Guidelines which is not a legally-binding instrument. It contains guidelines on conducting biosafety related research and provides an administrative procedure for handling relevant applications. This paper concludes that the laws under review do not provide a comprehensive legal framework to address biotechnology and biosafety issues. It recommends that a comprehensive law should be developed for this purpose backed by a national policy on biosafety for Bangladesh.

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