

PROTECTION OF TRADITIONAL KNOWLEDGE – AN INDIAN PERSPECTIVE

By

–Dr. G.B. REDDY,
Associate Professor in Law,
University College of Law,
Osmania University,
Hyderabad

“Till recently, the world’s richest man was an oil worker. Today he is a knowledge worker”. This statement sums up the importance of the knowledge in a rapidly changing society, the world over¹. In the good old days, the popular adage was that ‘knowledge is power’ but in modern times, knowledge has been recognized not only as a source of power but also as the primary source of property. It is this recognition that justifies the protection of intellectual property (IP) created either by individuals or by communities. The traditional forms of IP like patents, trademarks, copyrights and designs fall into the categories of individually created IP where the beneficiaries of the Protection of such IP are primarily the individuals, at least during the limited period during which they enjoy monopoly rights. After the expiry of the statutory period of protection, such IP flows into public domain. On the other hand, there are certain other forms of IP, created, owned managed and continued by the communities for considerable durations of time. Traditional Knowledge (TK) is one of such community owned and managed IP. The IP in the form of patents, trade marks and designs *etc.*, is created, generally as a result of the phenomenal growth in the field of science and technology during the last few

centuries. The TK on the other hand, has been passed on to one generation from the other, from time to time immemorial, and most of the times the developments in the field of science and technology have no bearing on such TK. It is the result of the experience, culture and need based actions of certain communities, which hitherto remained far from the urbanization and civilization. Traditional knowledge is a multifaceted concept that encompasses several components. What characterizes traditional knowledge is the fact that, generally, it is not produced systematically, but in accordance with the individual or collective creators’ response to and interaction with their cultural environment.²

There is an ongoing controversy regarding the commercial exploitation of the TK by the Multi-National Corporations mostly belonging to the developed countries. Such exploitation naturally affects the interest of the communities, which can be described as the custodians of different kinds of TK. As a result, certain uses of medicinal plants, indigenous systems of medicines such as *Ayurveda*, agricultural methods, folklore, traditional designs in textiles *etc.*, which constituted the general forms of TK and Indigenous Knowledge are facing new challenges from the developed world. The

1. J.K. Rowling earned 24.8 million pounds (\$ 36.2 million) in the year ending July 2007. Queen Elizabeth has an annual income of 15.2 million pounds (\$22.2 million). Coca-Cola has a brand value of \$69.6 Billion (51% of stock market value of the company). Mexico’s Carlos slim Helu, owner of America Movil, Mobile Network is the richest person in the World with \$67.8 million as compared to Bill Gates with \$59.2 million (as on 3rd July, 2007)

2. Information Note on Traditional Knowledge, prepared by the International Bureau of WIPO circulated at the WIPO Forum on “Intellectual Property and Traditional Knowledge: Our Identity, Our Culture” organized by the WIPO in Cooperation with the Government of the Sultanate of Oman, Muscat, Jan.21 and 22, 2002, See www.wipo/ipkt/mct/02/inf/3

TK is related to different forms of IP like the patents, trademarks, and geographical indications and it can be exploited by any of the above modes

This paper makes an attempt to analyze the concept of TK, difference between TK and Indigenous Knowledge, its growing importance commercially and otherwise particularly with regard to the third world countries with rich bio-diversity like India, and the need for effective protection of the TK in the interest of the developing countries which have been at the receiving end of being accused of committing theft of IP of the developed countries. The special focus however is on the Indian perspectives on Protection of TK.

Definition of TK

There appears to be no definition of TK universally accepted. Different persons define them differently depending on their intellectual persuasion and professional interest. Many of them use the concept of TK interchangeably with that of indigenous knowledge (IK).

TK is a knowledge, which is held by members of a distinct culture and/or sometimes acquired "by means of inquiry peculiar to that culture, and concerning the culture itself or the local environment in which it exists."³

On the other hand IK is that knowledge that is held and used by people who identify themselves as indigenous of a place based on a combination of cultural distinctiveness and prior territorial occupancy relative to more recently arrived population with its own distinct and subsequently dominant culture.⁴ IK fits neatly in the category of TK but TK need not fit in the category of IK. In other words, all IK is TK but all TK is not necessarily IK. TK is therefore the totality of

all knowledge and practices whether explicit or implicit, used in the management of socio-economic and ecological facets of life. It is based on past experiences and observations and is usually a collective property of a society. This knowledge is transmitted from one generation to other generation.⁵ Examples of Traditional Knowledge include knowledge about the use of specific plants and/or parts thereof, identification of medicinal properties in plants and harvesting practices. In India the TK includes the usage of Neem, Turmeric and Tamarind *etc.*, for medicinal and other purposes and Ayurveda system of medicine. It is also related to traditional designs, songs dances that have been used by the fashion and entertainment industries to create works which are protected by the IP. In other words they include the traditional folklore.⁶

While a number of definitions for TK have been put forward, there is no widely acceptable definition for it. In its report on a series of fact-finding missions, the World Intellectual Property Organization (WIPO)⁷ sought to summarize the concerns of TK holders as follows:

- Concern about the loss of traditional life styles and of TK, and the reluctance of the younger members of the communities to carry forward traditional practices
- Concern about the lack of respect for TK and holders of TK

5. See generally Dr. John Mugabe, Intellectual Property Protection and Traditional Knowledge – An Exploration in International Policy Discourse, Paper presented for the World Intellectual Property Organization (WIPO), Geneva, December, 1998.

6. See, Footnote 1, *Supra*.

7. WIPO (1999) "Intellectual Property Needs and Expectations of traditional knowledge holders", WIPO Report on Fact-Finding Missions 1998-1999, WIPO, Geneva (Publication Number 768E), Source: <http://www.wipo.int/globalissues/tk/report/final/index.html>

3. UNEP/CBD/COP/3/Inf.33, Annex ii

4. *Supra* note 1.

- Concern about the misappropriation of TK including use of TK without any benefit sharing, or use in a derogatory manner.
- Lack of recognition of the need to preserve and promote the further use of TK.-

The unique nature of TK is that the common property resources are not controlled by a single entity. Access to these resources is limited to members of an identifiable community. Each user has a separate entitlement to the common property and no single user has the right to abuse or dispose of it. More often, users of common property are subject to rules and restrictions embedded in cultural or religious customs. The net result of such customs and practices is that the users perceive themselves mainly as possessors of their habitat but not as resource owners. In other words, the members of the community have only community rights.⁸

The third world countries mostly in the continents of Africa and Asia have accumulated a broad technological base conserve and sustainably use plant genetic resources. The local people embodying traditional lifestyles and knowledge have devised and deployed various technologies to conserve the environment in general and bio-diversity in particular. For instance local communities and households in different parts of Africa have accumulated a broad technological knowledge base to conserve and use plants and their genetic component. These systems include *home gardens*, *seed banks* and *sacred grooves*. In Ethiopia, for example the Tigray Communities' efforts specifically address the problems of home gardens and seed banking like the loss of traditional seeds (genetic resources) and TK for selection and conservation.

In India the TK is mostly used in textile designs, making medicinal preparations, folklore and cultivating certain agricultural products.

ECONOMICS OF TK

R.A. Mashelkar, in an illuminating article states that the issue of economics based on TK and biodiversity are far more complex. He observes that India, with approximately 8% of world's biodiversity and as one of the greater storehouses of TK, has the potential of becoming a major player in the global trade in herbs-based formulations, medicines and products⁹. An estimate of the EXIM Bank puts the international market of medicinal plants-related trade at US \$60 billion per year growing at about 7% annually.

It may be noticed that, although trade in medicinal plants from developing countries has increased in the past few decades, with more drugs developed, little of any benefits accrue to the source countries and the traditional communities. According to an estimate, total trade in herbal remedies and botanicals in 1995 yielded over US \$56 billion and the only payments to the communities were for the manual labor involved. It is estimated that less than 0.001% of profits from drugs developed from natural products and TK accrue to traditional people who provided technical leads for the research¹⁰. Very few companies like Shaman Pharmaceuticals and Body Shop, appear to have developed some practices of returning some of the benefits from the commercialization of medicinal plants TK to the traditional people.

TK and Biodiversity

The TK is very closely related to biodiversity and genetic resources. The Convention on Biological Diversity (CBD), 1992 defines biodiversity as the "variability

8. See Patricia Kameri – Mbote, Community, Farmers' and Breeders' Rights in Africa: Towards a Legal Framework for Sui Generis Legislation, ICFAI Journal of Intellectual Property Rights, Vol.II No.4, November 2003 pp.57-78.

9. See R.A. Mashelkar, *Role of IPR in Economics of Knowledge*, Journal of IPR, Vol.6, July 2001, PP.271-276.

10. As quoted in John Mugabe, supra

among living organisms from all sources including *inter alia*, terrestrial marine and other aquatic ecosystems and the ecological complexities of which they are part, this includes diversity within species, between species and eco systems.”¹¹ The CBD imposes an obligation on member countries to respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation. It also provides that the members must make sustainable use of biological diversity and promote their wider application with the approval and improvement of the holders of such knowledge, apart from encouraging the equitable sharing of the benefits arising from the utilization of such knowledge, innovation and practices¹².

Even though the efforts to recognize and protect TK started way back in 1980s, with the WIPO and UNESCO adopting a model law and folklore, the concept of farmer's right was introduced by the FAO in 1989 into its international undertaking on plant genetic resources, the CBD was signed only in 1992 to promote and preserve TK. In spite of these efforts at the global level, that have spanned two decades, final and universally acceptable solutions for the protection and promotion of TK have not yet emerged.¹³ India has enacted the Biological Diversity Act, 2002 with a view to provide for conservation of biological diversity and sustainable use of its components, and fair and equitable sharing of benefits. The benefit claimers under the Act are the conservers of biological resources, their by-products, creators and holders of knowledge and information relating to the use of such biological resources and innovations.¹⁴

Some Instances of Bio-Piracy

Bio-piracy is understood as “the appropriation of the knowledge and genetic resources of farming and indigenous communities, by individuals or institutions seeking exclusive monopoly control over these resources and knowledge”¹⁵. This biopiracy usually takes place in the form of granting of ‘wrong’ patents, granting of patents to ‘inventions’ derived from a community's TK, or lowering the patent standards *i.e.*, allowing patents for inventions which amount to little more than discoveries or alternatively, the national patent regimes not recognizing some forms of public disclosure of TK as prior art.

There appears to be a feeling in the West that the developing countries like India which can be called “catch-up states” in contradistinction with the developed countries called “keep-ahead states” have caught up only by copying.¹⁶ In other words, the West feels that the third-world countries are very good at illegal copying; developing alternative processes for making patented drugs and reverse engineering. There doesn't appear to be complete truth in the said allegation. On the other hand, it can be safely stated that the West and the Multi-National Corporations (MNCs) from those countries have been exploiting the TK richly available in the third world countries, to the detriment of the traditional communities. In other words, when it comes to committing bio-piracy, it is the West that has to be blamed for its large-scale indulgence in the same. A few illustrations can be given to justify this hypothesis.

(a) ***Turmeric controversy:*** *Turmeric* (*Curcuma Longa*) is a plant of the ginger family yielding saffron-colored

11. See Article 2 of CBD, 1992

12. Article 8j of the CBD.

13. See the Report of the Commission on IPRs- Integrating IPRs and Development Policy, (2002), DFID, Government of UK, London at P.3

14. As defined under Section 2(a) of the Act.

15. As per the definition given by the Action Group on Erosion, Technology and Concentration (ETC Group) quoted in the Report of Commission on IPRs, *supra*

16. See *Lester C. Thurow*, “Needed: A New System of Intellectual Property Rights”, *Harvard Business Review*, Sept-Oct.1997 at p.100

rhizomes used as a spice for flavoring Indian cooking. It also possesses properties that make it an effective ingredient in medicines, cosmetics and a color dye. It has been in the public domain in India and used as such from the time immemorial. In 1995, two Indian nationals at the University of Mississippi Medical Center were granted US patent No.5401504 on 'use of turmeric in wound healing'. The Indian Council of Scientific and Industrial Research (CSIR) opposed this after its grant and revocation of the patent was sought. The CSIR maintained that, the use of turmeric for healing wounds and rashes has been in the public domain of TK for thousands of years. It supported its contention by documentary evidence, including a Sanskrit text and a paper published in the Journal of Indian Medical Association (1953). It is gratifying to know that despite the arguments by the patentees, the USPTO upheld the CSIR objections and revoked the patent. This is a landmark case as it was the first time that a patent based on the TK of a developing country had been successfully challenged.

- (b) ***Neem controversy:*** *Neem* (*Azadirachta indica*) is a tree mostly grown in India and other parts of South and Southeast Asia. It serves many purposes as a natural medicine, pesticide and fertilizer. It has been proved that *Neem* extracts can be used against hundreds of pests and fungal diseases that attack food crops; the oil extracted from its seeds is used to treat colds and Flu; and mixed in soap, it is believed to offer low cost relief from malaria, skin diseases and even meningitis. The European Patent Office (EPO) granted European Patent No.0436257 in 1994 to the US Corporation W.R. Grace

and USDA for a "method for controlling fungi on plants by the aid of a hydrophobic extracted neem oil". In 1995 a group of international NGOs and representatives of Indian farmers filed a legal opposition against the patent on the ground that the subject matter of the patent had been known and used for centuries in Indian agriculture to protect crops, and thus was the invention claimed was not novel. In 1999, the EPO determined that according to the evidence 'all features of the present claim have been disclosed to the public prior to the patent application.... and the patent was considered not involving an inventive step'. Consequently, the patent was revoked by the EPO in 2000.

- (c) ***Hoodia Cactus Controversy:*** the *San*, a tribe who live around the Kalahari Desert in South Africa, to stave off hunger and thirst on long hunting trips, has traditionally eaten Hoodia Cactus. This was documented by a Dutch anthropologist in 1937. Scientists at the South African Council and Industrial Research (CSIR) have found this report only recently and after a thorough study patented Hoodia's appetite-suppressing element (P57) in 1995. They licensed it in 1997 to the UK biotech company, Phytopharm. In 1998, the leading pharmaceutical company Pfizer acquired the rights to develop and market P57 as a potential slimming drug and cure for obesity, from Phytopharm for up to \$32 million in royalty and milestone payments. On coming to know about the possible exploitation of their traditional knowledge, the San People threatened legal action against the CSIR on grounds of bio-piracy by claiming that their TK had been stolen, and CSIR had failed to comply with the

rules of the CBD, which require the prior informed consent of all stakeholders, including the original discoverers and users. In March 2002, an understanding was reached between the CSIR and the San whereby the San recognized as the custodians of TK associated with the Hoodia plant, will receive a share of any future royalties. This case demonstrates that with goodwill on all sides, mutually acceptable arrangements for access and benefit sharing can be agreed.

- (d) *The Case of Ayahuaska: Ayahuaska* (which means 'vine of the soul') is a ceremonial drink produced from the bark of *Banisteriopsis Caapi* by the shamans of indigenous tribes throughout the Amazon Basin for generations. This drink is used in religious and healing ceremonies to diagnose and treat illness, meet with spirits, and divine the future. An American, *Loren Miller* obtained US plant patent No.5751 in June, 1986, granting him rights over an alleged variety of B.Caapi he had called "Da Vine" claiming that it represented a new and distinct variety of B.Caapi and that the plant was discovered growing in a domestic garden in the Amazon rain-forest of South America. The Coordinating body of Indigenous Organizations of the Amazon Basin (COICA), an umbrella organization representing over 400 indigenous groups, came to know of the patent in 1994 and on their behalf the Center for International Environmental Law (CIEL) filed a reexamination request on the patent on the ground of lack of novelty or distinctiveness. It was also contended that the granting of the patent would be contrary to the public and morality aspects of the patent law. In November 1999, the USPTO rejected the patent claim on the ground of

prior art. However, further arguments by the patentee persuaded the USPTO to reverse its decision and announce in early 2001 that the patent should stand. The grounds appear to be technical.

- (e) *The Basmati Case:* Basmati is a variety of rice from the Punjab provinces of India and Pakistan. The uniqueness of this rice is that it is slender, aromatic and long. It originated in this region and is a major export crop for both the countries. Annual Basmati exports are worth about \$300 millions and represent the livelihood of thousands of farmers. In 1997, the US Rice breeding firm Rice Tec Inc was awarded a patent¹⁷ relating to plants and seeds, seeking a monopoly over various rice lines including some having characteristics similar to Basmati lines. Concerned about the potential effect on exports, India requested a re-examination of this patent in 2000. The patentee in response to this request withdrew a number of claims including those covering Basmati type lines. Now the controversy revolves around the use of Basmati and similar names like Texmati, Kasmati and Jasmati in USA and elsewhere on the ground that basmati is a generic term.¹⁸

The above few examples amply prove that it is the developed countries mostly that indulge in bio piracy. This has become possible due to many factors like lack of awareness about the importance of TK, absence of necessary and timely legislation, lack of co-ordination between the National Governments and NGOs, and failure on the part of various traditional people and communities to organize themselves to protect their TK and to share benefits as when the same is exploited by outsiders.

17. US Patent No.5663484

18. See the Hindu Business Line (Chennai), June 7, 1997.

Indian Legal Regime and Traditional Knowledge

In India there is no special law that deals with protection of TK. However the other Intellectual Property Laws have certain relevance to TK. The Patents Act 1970 as amended by the Patents Second Amendment Act 2002 provides that the applicant must disclose the source and geographical origin of any biological material developed in lieu of a description.¹⁹ Similarly Section 25 of the Act dealing with the opposition to grant of patent allows for opposition to file on the ground that “the complete specification” does not disclose or wrongly mentions the source of geographical origin of biological material used for the invention.²⁰

As regards the Designs Act, 2000 it prohibits registration of certain designs which are not new or original; or have been disclosed to the public anywhere in India or in any other country by publication in tangible form or by use or in any other way prior to the filing date.²¹

The Trade Marks Act 1999 clearly provides that the trade marks (i) which consists exclusively of marks or indications which may serve in trade to designate the kind, quality, intended purpose, values, geographical origin or the time of production of the goods or rendering of service or other characteristics of the goods or services (ii) which consist exclusively marks or indications which have become customary in the current language or in the *bona fide* and established practices of the trade shall not be registered.²²

Under the Copyright Act 1957, there are a number of provisions, which provide that a work, which is already published that is, which is already in public domain cannot be registered under the Act.²³

The Law, which appears to be more relevant for protection of TK, is the Geographical Indications of Goods (Registration and Protection) Act, 1999 which aims at registration and better protection of geographical indications relating to goods. The main object of the law is to prevent unauthorized persons from misusing geographical indications and to protect the consumer from deception. For the purpose of the Act geographical indications in relation to goods means an indication which identifies such goods as agricultural goods, natural goods, or manufactured goods as originating or manufactured in the territory of the country, region or locality in that territory where a given quality or reputation is essentially attributable to its geographical origin.²⁴ In other words geographical indications fall into the category of either appellations or origin or indications of source. For example one can quote Pochampalli Saree, Vinukonda rice, Hyderabad Biryani, Basmati, Nagpur Oranges and Kashmiri Apple to indicate geographical indications and the TK is responsible for production of such goods in the specified areas. This Act enables the authorized users who may also include the representatives of the traditional communities to register GIs as well as themselves in respect of a definite territory of a country, or a region or a locality in that territory.²⁵ It is worth mentioning that the Ethiopian Intellectual Property Office (EIPO) has taken steps recently to use a wide ranging IPRs to differentiate their Coffee in the market place and to achieve higher returns. They

19. Under Section 10 clause (d) dealing with contents of specifications.

20. Under Section 25 (1)(j) of the Act as amended in 2002.

21. Section 4 of the Designs Act, 2000.

22. Section 9(1)(b) and (c) dealing with absolute grounds for refusal of registration.

23. See Sections 4, 13, and 16 *etc.* It may also be noted that the folklore is protected under category of Performers Rights under the Act.

24. Section 2(1)(e).

25. See Sections 7 and 8 of the Act.

bagan filing applications to register the names *Harrar/Harar*, *Sidamo* and *Yirgacheffe* as trademarks in key market countries.²⁶

India has enacted the Biological Diversity Act, 2002 with a view to provide for conservation of biological diversity and sustainable use of its components, and fair and equitable sharing of benefits. Without obtaining prior approval of the National Biodiversity Authority, to be set up, no person can apply for any intellectual property right in or outside India, for any invention based on research or information on a biological resource obtained from India²⁷.

Another relevant legislation pertaining to TK in farming is the protection of plant varieties and Farmers' Right Act 2001 which aims to protect the farmers' traditional rights including the rights to save, use, share or sell his farm produce of a variety protected under the Act. This Act also facilitates equitable sharing of benefits arising out of the use of plant genetic resources that may accrue through a breeder from the sale disposal *etc.*, of the seeds and planting material of a protected variety. The village and farming community will be compensated in case their traditional or local variety is used for the development of new varieties.

From the above brief survey of the various types of intellectual property related legislation shows that unauthorized persons cannot exploit anything truly forming part of TK commercially. However the laws are yet to become fully operational and effective till now. The Government is under an obligation to protect the TK by establishing various offices like Registry of Geographical Indications, National Biodiversity Authority and National Gene Fund. However the attitude of the Government appears to be

lackadaisical and the net result is the indiscriminate exploitation of the TK from India. Further the existing laws are not adequate to deal with all aspects of TK comprehensively. The only viable solution for better protection of TK is to enact a *Sui Generis* law to preserve and promote it for the benefit of future generations.

Conclusion :

The foregoing discussion shows that human communities have always generated, refined and passed on knowledge from generation to generation. Such traditional knowledge is very often an important part of their cultural identity and has been playing a pivotal role in the daily lives of the vast majority of the people. TK is essential to the food security and health of millions of people in the developing world. Further, it is also essential to continue the rich culture and heritage in the form of folklore and designs *etc.*

Very unfortunately the TK has become the subject-matter of bio-piracy at the hands of the developed world and its multinational corporations. It has become possible due to the failure as well as indifference on the part of national Governments and also people of third world countries where the TK is abundantly available. India is not an exception to this sorry state of affairs. Some of the illustrations given in this article show how complacent Indian Government was when some of its traditional products were sought to be patented in USA and Europe.

In order to protect our country's TK effectively and to curb the bio-piracy, the following measures may be suggested.

- (1) A *Sui Generis* legislation may be enacted to protect the traditional knowledge.²⁸

26. See "Making the Origin Count: Two Coffees", WIPO Magazine-September 2007

27. Under Section 6 of the Act.

28. Philippines have already enacted a legislation Indigenous Peoples' Rights Act of 1997 Source: <http://www.grain.org/docs/philippines-IPRA-1999-en.pdf>, and Community Intellectual Rights Protection Act, 1994.

Such a law should address the rights of the indigenous community over their TK, control of access to TK and benefit sharing;

- (2) A database on all kinds of TK available in different parts of India has to be created and before any patent, trademark or design is granted it must be made mandatory to search this database for the purpose of ascertaining that there is no prior use, prior knowledge or prior art;
- (3) The digital libraries of TK should be incorporated in and linked to every patent office to be searched during the processing of patent application. This is essential as most of the TK is commercially exploited through patenting it; and
- (4) All the Intellectual Property related laws in India may be suitably amended to ensure that any knowledge which is a part or result of TK cannot be protected in the form of a patent, trademark, or design *etc.*

It may be mentioned that one cannot blame the Government alone in not protecting

the TK. It is a duty of the traditional people, NGOs and also WIPO²⁹ and other similar institutions to ensure there is greater documentation of TK, better sensitization about it for preventing the granting of unwarranted patents. Proper documentation may contribute to the preservation, promotion and possible exploitation of TK for the betterment of mankind.

At the same time it may be remembered that beyond the legal requirements for the patenting of cell lines³⁰, genetic constructs³¹, and, transgenic animals and plants lie cultural issues that raise the question of whether such biological material should be patented, even if patentable. International debate has been stimulated by the patenting of human cell lines isolated from clinical samples of indigenous people, the patenting of new varieties of plants that have been considered cultural assets, such as Basmati rice, and the construction of transgenic animals and plants used for medical research and agriculture. As the world evolves a more integrated economy, many of these intercultural views raise religious, economic, and sociological issues that require ethical as well as legal analyses³². This paper is a humble attempt at making one such legal analysis.

29. WIPO has already constituted the Inter Governmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore (IGC) in 2000 and it has been very active in recent times and in preparing policy, legal options and laying guidelines for access and benefit sharing with regard to traditional knowledge. For more information see www.wipo.int/globalissues/tk

30. For instance, the patenting of human genetic material, *e.g.*, on the human cell line of a hahai tribesman from Papua New Guinea (US Patent No.5,397,696)

31. Such as US Patent No.5723765 granted to Delta and Pine Land Co., nick-named as the Terminator Technology for its potential of stopping plant regeneration after the first generation.

32. *Francis L. Macrina*, *Scientific Integrity-An Introductory Text with Cases*, 2 Ed, 2000, ASM Press, Washington, D.C. P.197.