Food Security and Biotechnology in Africa

This project is financed by the European Union and implemented by the ACP Secretariat

# MODULE 5

# ETHICS AND WORLD VIEWS IN RELATION TO BIOTECHNOLOGY

**Prof. Jerry O. Ugwuanyi / Dr. F. I. Akaneme**

**University of Nigeria, Nsukka**

**Module 5 Unit 3: Ethical issues in the uptake of Biotechnology**

**Lecture 1**: Rules for Discussing Bioethical Issues; *Emphasis on civility and mutual respect* **(1 hour Lecture / Discussion)**

**Learning Outcomes**

**Students are expected to**

- **Understand basic rules for discussing ethical issues; what should guide discussions?**
- **Agree rules for discussing bioethical issues,**
- **Recognise the multiplicity / diversity of possible positions in bioethics & the need to respect those in decision making.**
- **Understand the importance of civility and mutual respect in discussing ethical issues**

Final version, February 2017

*Disclaimer*

This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union.

**Element of Biotechnology & Bioethics (Recap; Overlaps in Biotechnology with module 2; light re-emphasis in the area of ethics)**

Biotechnology Defined: "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use" (UN Convention on Biological Diversity, Art. 2)

Bioethics and Biotechnology (Taken from *Modern Biotechnology: Legal, Economic and Social Dimensions, Biotechnology,* Volume 12, ed. D. Brauer (Weinheim, Germany: VCH, 1995). Author: Darryl R. J. Macer

**A. Bioethics**

Bioethics considers the ethical issues raised in biology and medicine, and especially those raised by human activity in society and the environment using biotechnology. The word "biotechnology" simply means using living organisms, or parts of them, to provide goods or services. The word can apply to agriculture in the past thousands of years, but is often used to apply to new techniques. We should not forget that all civilisations were formed needing food, clothes, and medicines, and in that sense biotechnology is not new. What is new is that we can now make new varieties much more quickly, and with greater variation - and some foodstuffs made from plants bred using genetic engineering are already being sold in parts of the world.

Bioethics considers issues affecting all living organisms and the environment, from individual creature to the level of the biosphere in complexity. All living organisms are biological beings, and share a common and intertwined biological heritage. The term bioethics reminds us of the combination of biology and ethics, topics that are intertwined.

Bioethics especially includes medical and environmental ethics. The word was mainly applied for issues of medical ethics in the 1970s and 1980s, but the 1960s and 1990s saw much more attention on environmental ethics. We must include both, medical ethics includes any factor affecting health, and ecological and environmental ethics must include human-human interactions, as these interactions are one of the dominant ecological interactions in the world. Agricultural systems include economic, environmental and human interactions. To

resolve the issues, and develop ideals or principles to help us do so, we must involve anthropology, sociology, biology, religion, psychology, philosophy, and economics; we must combine the scientific rigor of biological data, with the values of religion and philosophy to develop a world-view. Bioethics is therefore challenged to be a multi-sided and thoughtful approach to decision-making so that it may be relevant to all aspects of human life.

Some academics have tried to define more precisely what bioethics is, and basic principles. There are two basic approaches, one being descriptive and the other being prescriptive. One describes how people makes decisions, and the other suggests the process that can be used to make decisions. However, bioethics is not to prescribe the correct "answer", only the process that is used to decide. To make good choices, and choices that we can live with, improving our life and society, is certainly a good thing. However, what is good for one person may not be good for the broader society, and the global nature of agricultural economics and environmental impact, makes us think of the global arena. The choices that need to be made in the modern biotechnological and genetic age extend from before conception to after death - all of life.

There are large and small problems in ethics; there are global, regional, national, community and individual issues. We can think of ethical issues raised by biotechnology that involve the whole world, and issues which involve a single person. A global problem such as global warming may be aided by global applications of biotechnology, for example to reduce net atmospheric carbon dioxide increase by reducing emissions or increasing biomass, however, excess consumption and energy use can only be solved by individual action, to reduce energy use. A regional issue is the risk presented by the introduction of new organisms or of an unstable genetically modified organism (GMO) into the environment, but it also involves individual responsibility to ensure that sufficient care and monitoring of the release is made. Other ethical issues arising from biotechnology that are thought of as individual issues such as genetic testing, or use of gene therapy, also have societal implications.

We hardly need to ask why we need ethics; rather we need to ask what principles and factors are crucial for guiding decision-making, especially over such a diverse spectrum of issues. Medical ethics involves decision making on a personal level, it concerns the patient and the health care professional, especially the physician. At a further level away may be many others who will be indirectly affected by such questions as the cost of very expensive treatment that takes funds away from other patients. At this level higher policy-making is required, as in the case of issues such as environmental risk, or intellectual property protection policy.

Some key principles of ethics are outlined below, with brief discussion of their relevance to biotechnology issues.

**Autonomy**

All people are different. This is easy to see, if we look at our faces, sizes and the clothes that we chose to wear. This is also true of the choices that we make. We may decide to play tennis, or golf, or chess, read a book, or watch television. These are all personal choices. In a democratic society we recognise that we have a duty to let people make their own choices. Above the challenges of new technologies, and increasing knowledge, the challenge of respecting people as equal persons with their own set of values is a challenge for all. This is also expressed in the language of rights, by recognising the right of individuals to make choices.

**Rights**

Legal rights are claims that would be currently backed by the law if the case went to court, while human rights are critical to maintaining human dignity but may not have yet attained legal recognition. The recognition of human rights has changed the situation in many countries, and many countries in the world have signed the U.N. Declaration of Human Rights (Sieghart, 1985), or one of the regional versions of this. This can be applied to many situations, for example, we all have a right to be involved in decisions about our country, the freedom of religion, or speech, to raise a family, to share in the benefits arising from scientific advances, and a right to a reasonable future. Respect for personal rights should change the nature of relationships between people in power and people without power from being characterised by authoritarianism or paternalism to becoming a partnership.

Ethics is not the same as law. Ethics is a higher pursuit, doing more than the law requires. The law is needed to protect people and to set a minimum standard, but you cannot determine good moral behaviour by settling cases in a court of law. We only need to think of medical litigation or environmental damage penalties, which can lead to huge sums of money being paid for accidents (or negligence) which cannot really be compensated by monetary reimbursement. The solution is to have more careful and moral physicians, companies, and politicians, and the replacement of monetary balance sheets by ethical values, as the primary motive of decision-making.

**Beneficence**

One of the underlying philosophical ideas of society is to pursue progress. The most cited justification for this is the pursuit of improved medicines and health. It has often been

assumed that it is better to attempt to do good than to try not to do harm. A failure to attempt to do good, working for people's best interest, is taken to be a sin of omission. Beneficence is the impetus for further research into ways of improving health and agriculture, and for protecting the environment. Beneficence supports the concept of experimentation, if it is performed to lead to possible benefits.

The term beneficence suggests more than actions of mercy, for which charity would be a better term. The principle of beneficence asserts an obligation to help others further their important and legitimate interests. It means that if you see someone drowning, providing you can swim, you have to try to help them by jumping in the water with them. It also includes the weighing of risks, to avoid doing harm.

Governments have a duty to offer their citizens the opportunity to use new technology, providing it does not violate other fundamental ethical principles. Just what the definition of fundamental ethical principles is may be culturally and religiously dependent, especially in the way that they are balanced when opposing principles conflict (see Sec. 3). Although different cultures vary, they all share some concept of beneficence and do no harm. People should be offered the option of using new technology in medicine and agriculture, and such applications should be made, providing internationally accepted ethical and safety standards are applied.

Beneficence also asserts an obligation upon those who possess life-saving technology, in medicine or agriculture, to share their technology with others who need it. This is relevant to biotechnology companies also, who may hold patent rights on particular processes, beneficence would assert that they must share it with others, even if they cannot pay for it. This may mean that companies share developments with developing countries, or give new drugs to individuals too poor to purchase them

**Do no harm**

The laws of society generally attempt to penalise people who do harm, even if the motive was to do good. There needs to be a balance between these two principles and it is very relevant to areas of science and technology, where we can expect both benefits and risks. Importantly, we must balance risks versus benefits of different and often alternative technologies, and then apply these comparisons to our own behaviour, as well as in determining government policy.

Do no harm is a very broad term, but is the basis for the principles of justice and confidentiality, and philanthropy. It can also be expressed as respect for human life and

integrity. This feature is found in the Hippocratic tradition and all other traditions of medical and general ethics. To do no harm is expressed more at an individual level, whereas justice is the expression of this concept at a societal level. Do no harm has been called the principle of non-maleficence.

Biotechnology and genetic engineering are providing many benefits, but there are also many risks. It is also unclear who will really benefit the most. It is important to see these benefits and risks in an international way because the world is becoming smaller and ever more interdependent. Biotechnology affects the lives of people throughout the world (Walgate, 1990). All people of the world can benefit if it is used well, through medicines, and more environmentally sustainable agriculture. However, biotechnological inventions that allow industrialised countries to become self-sufficient in many products will change the international trade balances and prosperity of people in developing and industrialised countries. If developing countries cannot export products because of product substitution the result may be political instability and war. This may in the end become the biggest risk. For example, the use of enzymic conversion of corn starch into high fructose corn syrup causes serious damage to the economies of sugar exporting nations (Sasson, 1988), and may already have caused political instability there. We need to remember national and international issues.

Although we will continue to enjoy the many benefits to humanity, and we may hope for environmental benefits, the price of the new technology is that it may make us think about our decisions more than in the past. This is long overdue! International food safety and environmental standards should be speedily developed to ensure that all people of the world share their protection, and no country becomes a testing ground for new applications.

**Justice**

Those who claim that individual autonomy comes above societal interests need to remember that the reason for protecting society is because it involves many human lives, which must all be respected. Individual freedom is limited by respect for the autonomy of all other individuals in society and the world. People's well-being should be promoted, and their values and choices respected, but equally, which places limits on the pursuit of individual autonomy. We also need to consider interests of future generations which places limits on this generation's autonomy. We also need to apply this principle globally, as discussed above, no single country should pursue policies which harm people of any country.

The key principle arising from the high value of human life is respect for autonomy of each individual human being. This means they should have the freedom to decide major issues regarding their life, and is behind the idea of human rights. This idea is found in many religions also. Part of autonomy is some freedom to decide what to do, as long as it does not harm others, also called individual liberty or privacy. Well-being includes the principle of "do no harm" to people, and to work for people's best interests.

Internationally, the area of biotechnology patent policy should be examined in light of public opinion and the principle of justice. Shared genetic resources should not be able to be owned by any one individual or company. At the same time, some patent protection for specific applications involving biotechnology need to be in place to encourage further research, and to make the results of such research immediately open for further scientific research.

**Confidentiality**

The emphasis on confidentiality is very important. Personal information should be private. There may be some exceptions when criminal activity is involved or when third parties are at direct risk of avoidable harm. It is very difficult to develop good criteria for exceptions, and they will remain rare. We must be careful when using computer databanks that contain personal information, and if they cannot be kept confidential, the information should not be entered to such a bank.

A feature of the ethical use of new genetics is the privacy of genetic information. This is one of the residual features of the existing medical tradition that needs to be reinforced. It is not only because of respect for people's autonomy, but it is also needed to retain trust with people. If we break a person's confidences, then we cannot be trusted. If medical insurance companies try to take only low risk clients by prescreening the applicants, there should be the right to refuse such questions (Holtzman, 1989). The only way to ensure proper and just health care is to enforce this on employers and insurance companies, or what is a better solution, a national health care system allowing all access to free and equal medical treatment. We need to protect individuals from discrimination that may come in an imperfect world, one that does not hold justice as its pinnacle.

**Animal Rights**

These above principles apply to human interactions with other humans. However, we also interact with animals, and the environment. The moral status of animals, and decisions about whether it is ethical for humans to use them, depends on several key internal attributes of

animals; the ability to think, the ability to be aware of family members, the ability to feel pain (at different levels), and the state of being alive. All will recognise, inflicting pain is bad so if we do use animals we should avoid pain (Singer, 1976). If we believe that we evolved from animals we should think that some of the attributes that we believe humans have, which confer moral value on humans, may also be present in some animals (Rachels, 1990). Although we cannot draw black and white lines, we could say that because some primates or whales and dolphins appear to possess similar brain features, similar family behaviour and grief over the loss of family members to humans, they possess higher moral status than animals that do not exhibit these. Therefore, if we can achieve the same end by using animals that are more "primitive" than these, such as other mammals, or animals more primitive than mammals, then we should use the animals at the lowest evolutionary level suitable for such an experiment, or for food production (which is by far the greatest use of animals). If we take this line of reasoning further, we conclude that we should use animal cells rather than whole animals, or use plants or microorganisms for experiments, or for testing the safety of food.

Animals are being used for genetic engineering, for use as models of human disease, for use in the production of useful substances such as proteins for medical use, and in the more traditional uses in agriculture. Some of these uses, such as the production of mutations in strains of animal to study human disease will have human benefit, but are more ethically challenging because some of these strains may feel pain (Macer, 1989, 1991a).

**Environmental Ethics**

Humans also have interactions with the environment, and in fact depend upon the health of the environment for life. The easiest way to argue for the protection of the environment is to appeal to the human dependence upon it. There are also human benefits that come from products we find in nature, from a variety of species we obtain food, clothing, housing, fuel and medicine. The variety of uses also supports the preservation of the diversity of living organisms, biodiversity. As we have learnt, the ecosystem is delicately balanced, and the danger of introducing new organisms into the environment if that may upset this balance is another key issue raised by genetic engineering. However, we have been using agricultural selection for 10,000 years, so the introduction and selection of improved and useful microorganisms, plants and animals is nothing new, and we should learn from mistakes of the past.

The above arguments should convince people of the value of the environment, and that is a first stage. However, it appeals to our sense of values based on human utility. There is a

further way to argue for the protection of nature and the environment, and it is a more worthy paradigm. It is that nature has value for itself because, it is there. We should not damage other species, unless it is absolutely necessary for the survival of human beings (not the luxury of human life). Nature has life, thus it has some value. Another paradigm for looking at the world is a religious view, that God made the world so the world has value, and we are stewards of the planet, not owners. This paradigm can make people live in a better way than if they look at the world only with the paradigm of human benefit.

There needs to be examination of the view of nature that different people have, so that we can find what the commonly acceptable limits to modification of nature, plant and animal varieties, and human beings are. In the modern world any new science can easily spread, so researchers are accountable to all peoples of the world. There will be future possible applications of technology which are against "common morality", yet there is little research on what is acceptable. We need to know what these perceived of changing nature are, before we grossly change the characters of individual organisms or make irreversible changes to the ecosystem and the human society.

Microorganisms are generally placed at the lowest end of the "scale" of ethical status, because the only internal character they have is the state of being alive. External factors from a human aesthetic viewpoint mean that the only argument usually applied to them is human utility. Biodiversity may have some value in itself, though it is yet to be defined in non-religious terms. If we want to preserve biodiversity, it is essential that we separate parts of nature on land and ocean as nature reserves or parks, away from the parts of nature which are agricultural areas. However, while we separate these areas physically we should not separate them psychologically as areas which we can abuse and areas which we protect. This applies both in terms of sustainable environmental protection and animal rights. In fact, agricultural biodiversity is of direct human utility, and we should attempt to stop its continued loss.

**Taking Bioethics decision (refer to Biotechnology and Bioethics: What is Ethical Biotechnology?** *Modern Biotechnology: Legal, Economic and Social Dimensions, Biotechnology*, Volume 12, ed. D. Brauer (Weinheim, Germany: VCH, 1995). Author: Darryl R. J. Macer

**Module 5 Unit 3: Ethical issues in the uptake of Biotechnology**

**Lecture 2**: **Ethical issues associated with crop, animal and environmental biotech (2 hours)**

**Learning Outcomes**

- **Students are expected to**
  - **Understand major ethical issues relating to crop biotechnology**
  - **Understand major ethical issues relating to animal biotechnology**
  - **Understand major ethical issues relating to environmental biotechnology**
  - **Develop an appreciation of how intrinsic, extrinsic factors/arguments as well as rights etc. affect bioethical decision making**

Taken from: ROGER STRAUGHAN, & MICHAEL J. REISS **ETHICS, MORALITY AND CROP BIOTECHNOLOGY; UK:** Biotechnology and Biological Sciences Research Council

The moral concerns expressed about modern biotechnology cover a wide range but may for convenience be divided into two basic categories, to be labelled "intrinsic" nd "extrinsic". Biotechnology in general and crop biotechnology in particular may for a variety of reasons be thought to be either intrinsically wrong *in itself* or extrinsically wrong *because of its consequences.*

- This important distinction can be applied to a large number of moral issues and can often help in identifying the precise grounds of any moral concern. Confusion can quickly arise if the distinction is not drawn. A debate about the rights and wrongs of abortion, for example, will not get very far if the participants fail to realise that one (intrinsic) set of arguments –that abortion is murder and thus always wrong in itself- is radically different from and so cannot be countered by another (extrinsic) set of arguments- that the consequences of allowing certain pregnancies to continue are sometimes morally unjustifiable.
- Intrinsic arguments cut deeper than extrinsic ones. If abortion, biotechnology or anything else is thought to be intrinsically wrong, no further considerations are morally relevant, for nothing can reverse that intrinsic wrongness; consequences and intentions do not have to be taken into account.

## INTRINSIC CONCERNS ABOUT CROP BIOTECHNOLOGY

### Is Crop Biotechnology Blasphemous?

It is possible to hold religious views to the effect that modern biotechnology is blasphemous. These views may rest upon the belief that God has created a perfect, natural order; for people to attempt to "improve" that order by manipulating DNA, the basic ingredient of all life, thereby crossing species boundaries instituted by God, is not merely presumptuous but sinful. The essence of this concern, then, is that modern biotechnology is trying to "displace the first Creator", but in assessing such claims, the following points need to be noted.

1. By no means *all* religious believers would make these claims. Different religions have different perspectives upon the nature of God and the creation. For example, in Hinduism, the world's oldest major religion, all life is sacred. Visnu, as supreme being, endlessly creates the worlds of matter and withdraws it into his existence time after time as the cycle of seasons endlessly repeats itself In the Vedic literatures, mother Earth is personified as the goddess Bhumi, or Prithvi, the abundant mother who showers her mercy on her children. It is not surprising that Hinduism views humanity as having a great responsibility towards the Earth. In Judaism, too, there is a strong emphasis on the responsibilities that humans have towards nature. Agricultural land was supposed to lie fallow every seventh year as a sabbath of sacred rest. Further, every 50 years, on the day of Atonement in the Jubilee Year, all land must return to its original owner. Because the Earth is the Lord's, no one has unconditional land rights. In Buddhism there is a very strong emphasis on how we should relate to the natural world; for example there is a prohibition on the taking of animal life. Although Buddhism exists in many different forms, human responsibility towards the creation is a common theme, though the word 'creation' is somewhat inappropriate as the Buddha taught that there is no creator God as the first cause, because there is no beginning. While Buddhism teaches that humans, unlike other creatures, have the opportunity to realise enlightenment, it does not teach that humanity is superior to the rest of the natural world. Among Christians there is no unanimous condemnation of modern biotechnology. There is, for example, scriptural support for the view that humanity has been given by God an approved, privileged position of "dominion" over nature. Some modern theologians even see biotechnology as a challenging, positive opportunity to work *with* God as "co-creator".

ii. Crop biotechnology moves genes from one species to another, but religious believers do not necessarily hold that the boundaries between species are sacred and immutable, nor

indeed that they are so regarded by God. For all except" creationists", who believe in changes only within fixed limits of originally created kinds of plants and animals, evolutionary theory is more likely to suggest a view of species as provisional and fluid collections of individuals, each species playing its part in a developing process, initiated by God, of which we ourselves are a fairly recent product. Two final points relate not only to the question of blasphemy but also to many of the other moral concerns which may be felt about crop biotechnology. They will recur throughout this booklet, and will be referred to as the "agricultural argument" and the "traditional argument".

iii. The Agricultural Argument. Moral qualms of various kinds about *human* and *animal* applications of genetic manipulation seem to carry more weight than concerns about *agricultural* applications, and public opinion surveys show that such a distinction is in practice commonly drawn. It is probably based on the assumption that humans and animals are *sentient* (feeling) beings, whereas plants (as far as we know) are non-sentient and so cannot suffer. It is likely, then, that genetic engineering of plants will occasion far less concern than would the use of animal or human genetic material. For most religious believers the genetic manipulation of a tomato, for example, is unlikely to be seen as a sin.

iv. The Traditional Argument: Many of the moral concerns expressed about *modern* biotechnology are equally applicable to *traditional* methods of selective breeding. The blasphemy issue illustrates this point well, for if it is indeed blasphemous to "interfere with the created order", then such blasphemy was perpetrated for a very long time before modern biotechnology was ever heard of In fact it is difficult to think of *any* human activity that does not "interfere with the created order" in some way. Certainly all forms of agriculture and horticulture fall into this category, yet it is surely odd to condemn the watering, .feeding and protection of plants, the cultivation of the soil and the removal of weeds as acts of blasphemy. So what weight are we to conclude should be attached to the charge of blasphemy? The above points suggest that this concern presupposes a particular set of views about creation, evolution and purpose, which if made explicit would probably not be shared by a majority of religious believers today.

**Is crop Biotechnology Unnatural?**

A belief that modern biotechnology is intrinsically wrong need not rest upon a religious basis. Agnostics and atheists would be unmoved by arguments about blasphemy, but might still

share what seems to be a widely felt concern that biotechnology is in some sense "unnatural" and therefore wrong. Reduced to its simplest form, the argument seems to be as follows: "Nature and all that is natural is valuable and good in itself; all forms of biotechnology are unnatural in that they go against and interfere with nature, particularly in the crossing of natural species boundaries; all forms of modern biotechnology are therefore intrinsically wrong". To examine this argument, we need to ask two fundamental questions: first, what are meant by "natural" and "unnatural"?; secondly, what is good about being "natural"?

*What are meant by "natural" and "unnatural"?*

Before the above argument can even get off the ground, we have to be able to identify and agree about what is to *count* as "natural" and "unnatural". This is no easy task in a world where we are offered natural beef, natural toothpaste, natural birth-control and a host of other allegedly "natural" products and processes. Depending on the context in which it is used, the word "natural" may mean "usual", "normal", "right", "fitting", "appropriate", "uncultivated", "innate", "spontaneous" and no doubt many other things as well. Perhaps most commonly "natural" is contrasted with "artificial" or "man-made", but on the basis of that distinction practically every element of our modern Western life-style is "unnatural". Nor can more traditional products and processes avoid such a charge of "unnaturalness", for the progress of civilisation has been largely dependent upon humanity's "interference with nature". Yet if every domestic or farm animal, every garden plant or agricultural crop, every item of food or clothing is thought of as the result of "unnatural interference", then the concept of "unnaturalness" surely becomes so broad as to be meaningless. The more specific and serious charge of "unnaturalness" that has been levelled against modern biotechnology, however, is that it breaches natural species boundaries and violates the natural integrity of species. One problem with this argument is that biologists are unsure about the extent and even the definition of "natural species boundaries". Indeed the meaning of the term "species" is itself far from clearcut, depending very much on the context in which it occurs. The definition of "natural" and "natural species boundaries", therefore, creates serious problems which suggest that we are not likely to find much help here which will be of use in sorting out the ethical issues. But even if these difficulties of definition could be overcome, the argument about "unnaturalness" faces further ethical objections.

*What is good about being "natural"?*

The argument under consideration assumes that whatever is "natural" is good and whatever is "unnatural" is bad, but is this assumption warranted? A "natural" event, product, process or tendency (however defined) is not automatically good or desirable. Many "natural" substances are harmful; many of our "natural" tendencies and reactions, such as jealousy and aggression, are not normally thought morally praiseworthy; many "natural" events, such as earthquakes and hurricanes, create destruction and suffering, and are indeed usually labelled "natural" disasters; many "natural" organisms cause pain, disease and death. As the theologian Don Cup itt points out, nature can be seen as a **"kindly mother, lovely in every aspect"** but also as **"wild,** chaotic **and pitiless". (7)** Darwin, the founder of modern evolutionary theory, shared the latter view, lamenting the "clumsy, wasteful, blundering, low and horribly cruel works of nature". We cannot then simply deduce what is morally right and wrong from certain facts about the world and about nature, Simply because something happens in nature does not mean that we are morally unjustified in interfering with it. So even if natural species barriers can be identified (which may be difficult), their mere existence provides no clear ethical directives about what *ought* to be done about them. The River Thames, for example, is a "natural" barrier between Surrey and Middlesex, but that geographical fact tells us nothing about whether it is morally right or wrong to cross from Surrey to Middlesex. Claims about the "unnaturalness" of modern biotechnology, therefore, do not appear to have much ethical significance, resting as they do upon unclear language and unsound reasoning. An argument to the effect that genetically engineering a drought-resistant strain of plant, for example, is "unnatural" and therefore wrong would hardly stand up to much critical scrutiny. There are, however, more sophisticated versions of the "blasphemy" argument and the "unnatural" argument which some believe to carry greater ethical weight. These can take several forms but all focus in some way upon a lack of respect which modern biotechnology is thought to embody.

**Is Crop Biotechnology Disrespectful?**

What kind of disrespect might modern biotechnology be accused of showing, and toward what? There are two main arguments to examine here, each concerned with aspects of our relationship with the natural world.

**The reductionist argument**

Now of course it is possible for any researcher to come to adopt a red uctionist view of life as a result of his or her professional work, but that danger is just as great for the economist or social scientist (in terms of viewing human beings as mere statistics) as for the molecular biologist. If a biotechnologist finds that he is starting to see his wife, his children, his dog and his flower bed "reduced to a chemical level", the answer is surely not to outlaw biotechnology but for that unfortunate individual to seek psychiatric help. The "agricultural argument" is also again relevant here, for most people would probably feel that our imaginary biotechnologist was facing far greater moral and spiritual problems in "reducing" his wife and dog to a chemical level than in doing the same with his geraniums and tomatoes. In this respect also, therefore, the genetic manipulation of plants appears less vulnerable to moral censure than that of humans and animals. There is, however, a broader dimension to the reductionist argument which deserves to be taken more seriously, namely a concern that modern biotechnology shows a certain lack of respect for the environment. This leads us to the second argument to be examined.

**The holistic argument**

This set of views applies to a far wider range of issues than just biotechnology and embraces many ideas which are often loosely labelled "holistic", "ecological" or "environmental". Here is not the place to analyse these ideas in great depth, other than to note that they include claims and theories about the interdependence of all life-forms in a complex, self-regulating "biotic community" and the consequent extension of moral rights and moral value to the non-human world. So do modern biotechnological techniques in some way lack respect for the "biotic community"? The World Council of Churches Report on Integrity of Creation, for example, asserts that biotechnology is associated with: But what exactly is "respect" and how do we display a lack of it? And why should it be assumed that any scientist is *likely* to exhibit a lack of respect in the area of his or her particular expertise? Specialist knowledge and skills commonly lead to *greater* rather than *less* sensitivity, awareness and awe. Astronomers do not despise the heavens because they know a lot about them, nor do veterinary surgeons lose their respect for animals because they are skilled in treating them and operating upon them. So why should biotechnologists be thought automatically to lack respect for the living material which they are working with? The distinction between genetically manipulating plant material versus human or animal material can be aptly applied to the issue of respect. Engineering genetic modifications of farm animals, for instance, to produce commercially

valuable characteristics, possibly to the detriment of the animals' overall welfare and quality of life, invites the charge of disrespect far more convincingly than does the development of a plant which has been made genetically resistant to certain diseases or pests. Is it in fact at all meaningful to speak of showing disrespect to the plant kingdom? Finally, modern biotechnology seems no more or less open to the charge of disrespect than the traditional version. Selective breeding has always aimed at modifying life-forms to fulfil human requirements. So do genetically engineered tomatoes exhibit any more disrespect for nature than the amateur gardener's stringless runner beans or Fl hybrid cabbages?

**SUMMARY**

A variety of intrinsic concerns about the ethics of crop biotechnology has been reviewed in this section. These concerns stem from a number of separable but loosely linked assumptions about the religious and moral status of the natural world and about the relationship that humans should have with that world. Assumptions of this kind, some of which appear to be widely held, cannot be proved right or wrong, but they can and should be analysed in order to clarify the concepts and principles on which they implicitly depend. Some of the key questions to emerge from this section which you might ponder for yourself are:

1. Should religious believers see modern biotechnology as a blasphemous affront to God or a creative opportunity to work with God?

ii. What is the basis for claims that species are sacred and have fixed boundaries?

iii. In what sense could modern biotechnology be called unnatural?

iv. Can any moral guidelines be provided by what happens in nature?

v. How could one show disrespect towards plants?

vi. Is crop biotechnology open to the same charges of intrinsic moral wrongness that might be levelled against the manipulation of animal and human genetic material?

vii. Can any charges of intrinsic moral wrongness be brought against crop biotechnology which are not equally applicable to traditional methods of selective breeding?

## EXTRINSIC CONCERNS ABOUT CROP BIOTECHNOLOGY

### Extrinsic moral concerns arise from what are claimed to be undesirable *consequences* of crop biotechnology

These extrinsic concerns about crop biotechnology focus upon two main issues - safety and socio-economic effects. These will be analysed in this section, but we need initially to note a

major problem raised by these issues. To claim that any process will have dangerous consequences or will produce socio-economic inequalities is to make predictions about future events. But predictions may be accurate or inaccurate, and no conclusive proof can ever be provided that a particular set of events will inevitably occur in the future. Extrinsic concerns must therefore always be in this sense provisional: they carry weight only in proportion to the likelihood of the predicted consequences actually occurring. So to appraise the validity of these concerns becomes in part a technical matter of trying to establish what really is most likely to happen. Ethical questions, however, can still be directed at these extrinsic concerns despite their technical nature. Indeed it is essential that they should, for the following three reasons:

i. Even if agreement is reached about likely consequences (which, as we shall see, is rare) this does not automatically answer the moral and ethical questions. We still have to ask what is good or bad, right or wrong, *about* those consequences and examine the moral claims and assumptions surrounding them.
ii. There is never just *one* consequence to any activity but a whole *set* of consequences, often occurring at different times. The consequences of any activity, therefore, cannot simply be morally approved or condemned *en bloc*, for they will often produce conflicting advantages and disadvantages.
iii. Consequences, then, have to be *weighed* and *compared* against each other, and this cannot be a matter of purely factual assessment. Attempts to estimate the likely costs and benefits of an activity can of course be made on a straightforward financial basis, but this does nothing to address the moral issues. (Presumably a financial assessment of this kind was made in deciding the method of extinction to be used in Nazi concentration camps.) Ethical judgements have still to be made about the *value* or *priority* to be placed upon different possible costs and benefits produced by different possible consequences. This section will not, therefore, concentrate upon trying to establish "the facts" about the alleged risks and socio-economic effects of crop biotechnology, although some tentative assumptions will have to be made about likely and unlikely consequences. The aim will rather be to identify the range of moral concerns felt about the possible consequences of crop biotechnology, to analyse the logic of these concerns and to illustrate how the weighing of costs and benefits necessarily depends upon more fundamental value judgements.

**Is Crop Biotechnology Risky?**

Riskiness is not in itself a moral or ethical matter. It is more risky to drive on motorways on wet Friday evenings than on fine Sunday mornings, but this is a statistical fact rather than a moral issue. Some activities are inevitably more risky than others, though none can be totally risk-free, and it does not follow that low-risk activities (e.g. snoozing in front of the television) are morally superior to high-risk ones (e.g. rescuing children trapped in burning buildings). Risk and safety become matters of moral concern only when they raise further questions about *responsibility* and *justifiability*. Moral concern is appropriate when irresponsible and unjustifiable risks are thought to be taken, which may result in harm to innocent parties: joyriding at high speed in a stolen car arouses moral concern to a far greater extent than driving aracing car in a Grand Prix. Determining precisely what constitutes "irresponsible" risk-taking and when a possible benefit justifies a possible risk is highly problematic, however. What kinds of risk are claimed to attach to crop biotechnology, and are they sufficiently "irresponsible" and "unjustifiable" to merit moral concern? The main fears centre upon the release of genetically manipulated organisms into the environment and the possible harmful consequences of such procedures. Such consequences might include, it has been suggested, global drought caused by the genetically modified "ice-minus" organism (intended to protect crops against frost) and the spread of indestructible weeds, resistant to pests and herbicides. Further fears have been voiced that crop biotechnology might lead to a loss of genetic diversity: a reduced number of "supercrops" might prove to be less resilient and so more vulnerable to various forms of attack in the future. The risks envisaged here are clearly of such a catastrophic nature that no one (with the exception of the archetypal "mad scientist" of sensational fiction) would feel justified in turning a blind eye to them. So can we cut short our ethical investigation at this point by accepting that such risk-taking is irresponsible and unjustifiable on the basis of a moral principle to the effect that any activity which could lead to catastrophic consequences ought not to be undertaken? Unfortunately, this simple and apparently responsible conclusion becomes less convincing when we look more closely at the moral principle on which it depends. It is not uncommon to hear or read interviews in which scientists and politicians are asked, "Is X really safe?" and then accused of equivocation if they refuse (as they should) to give a straightforward yes or no answer. The simple logical truth, which is of some ethical relevance here, is that it is impossible to *prove* that a particular event will or will not happen in the future. No activity or process can ever be guaranteed to present no risk whatever and to be 100% "safe", and crop biotechnology is no exception to this logical rule. Any activity could conceivably lead to catastrophic

consequences. But how much weight should we place on this logical truth? Critics argue that the risks involved here are of such a level as to make the further development and application of modern biotechnology irresponsible; it is the particular and peculiar risks associated with these techniques that make them morally unjustifiable. Clearly the issue here is partly one of technical assessment. However, a number of more general considerations and counter-arguments have also to be taken into account in trying to reach a balanced evaluation of these moral concerns.

1. The possible harmful effects of crop biotechnology are entirely speculative; no instances have occurred in practice. Unlike most new technologies in their early stages of development, modern biotechnology has so far proved to be remarkably safe.
ii. Many scientists believe that this clean record indicates that modern biotechnology, far from being peculiarly risky, is in fact peculiarly safe - safer in fact than the relatively indiscriminate genetic exchanges that occur in traditional selective breeding, because the most a genetic engineer can do is add a limited number of genes to the tens of thousands of genes in an organism's chromosome. Modern biotechnology is therefore claimed by many to be a more precise and predictable procedure than traditional biotechnology.
iii. Furthermore it can even be argued that crop biotechnology is safer not only than traditional techniques but also than what goes on "naturally" in every garden and compost heap, where about a million bacteria are to be found in every gram of soil and in a state of constant mutation. The vast majority of these natural mutations do not survive, and it is questionable whether a new genetically engineered organism would be tough enough to launch an environmental take-over bid of the kind that some have envisaged.
iv. Stringent regulations have been introduced in those countries where biotechnological developments are taking place. In the United Kingdom, for example, the Advisory Committee on Genetic Manipulation, chaired by an eminent scientist and containing representatives from industry, Government, the trades unions and an independent environmental organisation, provides guidelines for risk assessment on a case-by-case basis and advises the regulatory body, the Health and Safety Executive. European directives are in place that covers laboratory work with genetically engineered organisms and the study of genetically engineered organisms in field trials. Another European Directive, relating to genetically engineered foods, is close to agreement, and the UK, in any case, has its own agreed procedures in this area. While it can always be argued that regulations are not strict

enough, there is little scope for irresponsible risk-taking of a Frankensteinian kind under the existing framework.

v. Excessive caution does not necessarily remove the risk of future catastrophes. By banning research and development in any new technology that is thought to involve risks, we may run the greater risk of failing to produce an innovation which will be desperately needed in some future, unforeseen crisis. The history of science has proved to be highly unpredictable, and there can be no guarantee that "playing safe" by abandoning research and development in crop biotechnology will not deny us a technique or product which may *prevent* an environmental disaster in fifty years. These points do not of course "prove" the safety of crop biotechnology (already shown to be an impossible task), but they do at least suggest that the case against crop biotechnology on the grounds of irresponsible risk-taking is far from overwhelming. Nevertheless, as it is logically impossible to guarantee the total safety of crop biotechnology, a value judgement has to be made about the acceptability and justifiability of the possible risks, and that judgement will involve the weighing of potential risks against potential benefits. Before trying to tackle this question, however, we shall first review in the next sub-section the possible socio-economic effects of crop biotechnology, for the weighing of costs and benefits is equally crucial in assessing moral concerns in that area also.

**Is Crop Biotechnology Unfair?**

The main worries about "unfairness" centre upon the economic *vulnerability* of poorer farmers and poorer countries to some of the possible effects of the new technology, and upon the economic *disadvantage* they are thought likely to suffer. Crop biotechnology will be expensive, it is claimed, and will favour large-scale, capital-intensive styles of agriculture; poor farmers will not be able to afford the new products and will lose out in the increased competition that will result. On a broader scale whole economies as well as individual farmers could be threatened, and the economic gap between the "developing" and the "developed" world could widen yet further. More specific charges have been made about the degree of profit-motivated "control" exercised by agro-chemical companies over small farmers, particularly again in poorer countries. Another problem is that genetic engineering may lead to products at present obtainable only from developing countries being made in Western laboratories. Suppose, for example, that genetic engineering could lead one day to the synthetic manufacture of artificial teas and coffees that really did taste as good as today's real versions. Many developing countries would lose huge amounts of income at present generated from the sale of tea and coffee exports. In addition, there is the emotive and

complex issue of *patenting.* The pace of modern biotechnological development has led to a re-examination of existing patent law, which in the United Kingdom has in fact covered biological "inventions" for over 100 years. In the USA the Patent Office issued a patent for a genetically engineered micro-organism in 1980, for a plant in 1985 and for an animal in 1988. In Europe too a Directive on the Legal Protection of Biotechnological Inventions allows the patenting of living organisms under certain circumstances. The most general moral concern expressed about patenting is that it is wrong to think of "life forms" as objects that can be "invented" and "owned". More specifically, however, it is claimed that biotechnological patenting will produce various "unfair" consequences, including:

i. Greater control by large corporations over small farmers through the payment of royalties, which could reduce their independence and even force them out of business.
ii. Misappropriation of Third World genetic resources by First World countries.
iii. Restriction of the free exchange of genetic material and the flow of information about it.
Genetic resources are the "common heritage of humanity" and free access to that heritage should be open to all. What ethical principles and problems are raised by this wide range of concerns? The following general points need to be noted in any analysis of this set of moral concerns:
1. History has demonstrated how all new technologies inevitably have far-searching socio-economic effects. Crop biotechnology cannot, then, be singled out as the sole target for moral censure on these grounds, any more than can information technology or the development of the steam engine, which caused some workers to lose their jobs and suffer economic hardship.
2. All new technologies tend to benefit *initially* the "developed" countries, because they have more resources and expertise available for research and development. But the fact that penicillin, for instance, was used to treat Western patients before it became available worldwide, is hardly a moral argument against the development of lifesaving drugs - though clearly there is a moral obligation upon those benefiting from a new technology to extend those benefits as widely and as speedily as is practicable.
3. On the issue of patenting there are moral points to be made on both sides. The patenting of every new product or process by definition places certain restrictions upon others who wish to use that product or process and who may judge the restriction to be "unfair", but why should this alleged "unfairness" be more morally objectionable in the case of a new strain of seed than of a new piece of farm machinery? Despite the charge of "unfairness", there is on

the face of it a straightforward ethical justification for the use of patents in general *in terms oj* fairness and justice. If I spend years of my life developing a revolutionary new product which may benefit millions of people, do I not deserve some recompense for my work and some protection against others who might otherwise capitalise upon my efforts? The emotive charge of "patenting and owning life" also loses much of its force when it is realised that the "ownership" involved is of the invention itself and not of living "matter". In the case of crop biotechnology a patent would imply ownership not of a seed or a plant, but of the invention of the "genetic kit" which produces a particular attribute of that crop. In any case, the logic behind moral objections about "owning life-forms" seems far from clear in view of the fact that we happily talk about owning cats and dogs and orchids and orchards without arousing moral indignation.

4. The claim that genetic resources are the "common heritage of humanity" and should thus be free for all to use and benefit from also stands in need of closer analysis. Genetic (and indeed all natural) resources are certainly "free" in the sense that they are present in the natural world without a price label attached, but that does not necessarily mean that they are "free" for anybody to take and use. Few natural resources are "free" in the sense that wild blackberries are. Controls and licences are needed to regulate their extraction, and financial investment is needed to pay for the costs. It is misleading, then, to imply that genetic resources needed for crop biotechnology are like fruits of the forest, free for all to pluck and eat. The above points do not mean that there will be no undesirable socio-economic effects of crop biotechnology, nor do they lessen the need for international political and economic action to prevent or minimise these by showing sensitivity to the problems of the most vulnerable individuals and communities. However, it is difficult to see why crop biotechnology should be singled out for particular moral criticism on socioeconomic grounds. But if the possibility of undesirable socioeconomic effects is to be added to the possibility of risk, do not these factors constitute a strong moral argument against crop biotechnology, despite the qualifications which have been listed in each case? This brings us back to the fundamental issue of the value judgements which have to be made about the acceptability and justifiability of the possible costs ·of crop biotechnology. Those value judgements, however, need to take into account *another* set of factors which has so far been referred to only briefly and indirectly, concerning the potential *benefits* of crop biotechnology which have somehow to be weighed against its potential costs.

**How to Weigh the Costs and the Benefits**

The potential benefits of crop biotechnology are easy to appreciate. Farmers are finding it increasingly difficult to grow enough food for an increasing world population, and by the year 2000 developing countries are expected to face a food deficit of over 100 million tons on the basis of the current rate of production. In addition, environmental conditions in many traditionally productive agricultural areas are deteriorating. New techniques and products, it is claimed, are needed to feed a hungry world and to start to redress the balance between the food supplies available to rich and poor countries. Crop biotechnology offers a possible, partial solution in the form of new, more productive strains which will be more able to resist diseases and pests and to withstand hostile environmental conditions. Additional benefits could also include less reliance on the use of pesticides and fertilisers, with the possibility of lower levels of environmental pollution. Any estimation of the potential benefits of crop biotechnology will again involve prediction and technical assessment – though it should be noted that some of these benefits are already occurring and are thus *actual* rather than potential, whereas real hazards have not yet appeared. The weighing of these costs and benefits, however, raises complex ethical problems regardless of the technical questions, and a number of factors need to be taken into account in attempting to reach a balanced evaluation:

1. Despite the suspicions of Western "control" and "exploitation" it seems undeniably true that crop biotechnology has at least the potential to bring substantial benefits to the poor and the hungry, and the moral significance of that potential cannot be ignored - though there is a danger of oversimplification here, as some would argue that hunger is caused as much by poverty as by direct food shortages. Of course any technology can be misused and its potential benefits dissipated (inorganic chemistry helped Hitler to perpetrate the Holocaust), but crop biotechnology appears to have a moral head-start in offering the prospect of at least helping to meet what many see as the most urgent moral demand of this generation - the prevention of starvation.

ii. It may also be presumptuous and insensitive for those of us in less urgent need of the potential benefits to place too much moral weight upon the possible costs. Less affluent countries and individuals are less able to afford the luxury of such cautious speculation, and to them the moral priorities may appear more obvious. The Chairman of a large Indian agricultural co-operative, for example, has declared that it is wrong, even immoral, to constrain production in a world of hunger. Failing to proceed with promising technologies, therefore, may be seen to be as morally wrong as running the risk of producing undesirable

consequences. As was suggested earlier, harm *may* result from developing the techniques of crop biotechnology, but harm may equally well result from *Jailing* to develop them.

iii. The precise methods by which costs and benefits are to be weighed against each other, however, is difficult to determine. There are familiar objections to the crude "utilitarian" view that actions are right or wrong in proportion to the total amount of pleasure or pain that they produce, which makes "the greatest happiness of the greatest number" (or in modern terms, the highest "cost-benefit ratio") the ultimate ethical test. Such a theory would, for example, require the compulsory introduction of a highly risky vaccine calculated to save ten thousand lives but to cause nine thousand deaths. To overcome such problems, some have suggested that we should weigh the likely harm an action might cause more heavily than the likely good it will do. There still remains the problem, however, of how these revised weightings are to be arrived at. Moreover, in the case of crop biotechnology, it is not obvious which option should be identified as the potentially harmful one, for harm may result from developing the technology or from not developing it. We must conclude, therefore, that there can be no simple straightforward way of weighing potential costs and beriefi ts to prod uce a clear ethical decision. Priorities have to be assigned to the competing costs and benefits, and those priorities will in turn reflect more fundamental value judgernents, which can never be *proved* right or wrong. Clearly there are no easy or obvious answers here. However, in trying to weigh the costs and benefits of crop biotechnology it seems reasonable to conclude that a high ethical priority should be assigned to the undoubted potential which this technology offers for alleviating human suffering.

**SUMMARY**

In this section extrinsic concerns about the ethics of crop biotechnology have been reviewed. Fears that the consequences of crop biotechnology may be dangerous or that the socio-economic effects may be inequitable have been examined and set alongside the potential benefits. As in the previous section a number of key questions can be identified for you to consider for yourself:

i. What level of technical understanding is required in making ethical judgements about the possible effects of crop biotechnology?

ii. When does risk-taking become "irresponsible"?

iii. Should the prime responsibility of scientists be to reduce risks to the absolute minimum, regardless of the anticipated benefits?

iv. What is morally objectionable about patenting life-forms?

v. Are the moral concerns expressed about the possible socio-economic effects of crop biotechnology significantly different from those associated with any new technology?
vi. If new technologies always start by distributing their gains unevenly, what measures might be taken to minimise this unevenness in the case of crop biotechnology?
vii. What ethical priorities should influence the weighing of the potential costs and benefits of crop biotechnology?

**Animal Ethics vs. Animal Welfare**

**For a detailed discussion of Animal Ethic refer to: R. Stroughan- Ethics Morality and Animal Biotechnology, BBSRC UK**

Why do animals matter ethically?

- The issue which has increasingly come to be seen as ethically significant is not the use of animals but their welfare.

- Sentiency: The capacity of animals to experience pain and pleasure
  - Speciesism: This refers to refusal to accord all sentient beings equal consideration. The result is preferential consideration for human beings over other animals.

In considering sentiency as an ethical principle two approaches may be adopted

- Utilitarianism: to maximize pleasure and minimize pain; how do we weigh different levels of human benefit against different levels of animal suffering?
- Inherent Value: this focuses not upon calculations of pain and pleasure felt by sentient creatures, but upon their inherent value as individuals, which gives them the right to be treated with respect.

Complications here will relate to the diversity in the animal kingdom

Intrinsic Concerns would hold that:

- If biotech is thought to be intrinsically wrong, no further considerations are morally relevant, for nothing can reverse that intrinsic wrongness (consequences and intentions notwithstanding)

Three areas of Intrinsic concern relevant to animal biotech explore whether animal biotech is:

- Blasphemous (transgenic animals/ moral status of animals)
- Unnatural
- Disrespectful

In these respects the arguments are similar in animal and plant biotech. However, in animal biotech concerns vary between animal biotech related to medicine & for food use

Patenting in animal Biotech

**Some questions peculiar to animal biotech**

Transgenic animals can create particular problems for some religious groups:

Halal / Unclean / Forbidden, etc.

- Would you be prepared to eat genetically modified turkey? What ethical concerns would you associate with that?
- Should genes from non-halal animal be used to improve halal ones

**Extrinsic Concerns** relate to what are claimed as the undesirable *consequences* of animal biotech.

Two areas of Extrinsic concern relevant to animal biotech are **Safety (risk)** & **Socio-economic** consequences of the process & products.

- Statements about safety and socio-economic consequences are predictions. These may turn out to be accurate or not and may or not happen!
- Extrinsic concerns are by their very nature provisional and carry weight only in proportion to the likelihood of the predictions happening

Extrinsic arguments related to animal biotech are comparable to those related to crop biotech.

**Risk concerns in Animal Biotech**

- That the speed with which animal biotech can effect changes in animals, making it difficult for the changes to be observed over many generations ( relative to traditional breeding).
- That this method of breeding might produce unexpected and harmful results for those who eat foods derived from such animals
- That animal biotech might narrow the gene pool and reduce genetic diversity, so producing monocultures which could be vulnerable to new diseases or other environmental threats.
- That animals engineered in biomedical research to be models of human diseases might escape and infect the human (and animal) populations, or generate new and more resistant strains of the disease.
- That organs from genetically modified animals might transmit viral diseases if used in human transplant surgery
- That genetically modified animals might be accidentally or deliberately released into the environment, causing various forms of ecological disaster

In spite of some of these concerns being unlikely to occur, regulatory bodies exist in countries that practice modern biotech to ensure that no one turns a blind eye to such risks.

**Environmental Ethics**

Generally speaking, environmental ethics deals with the moral dimension of the relationship between human beings and non-human nature−animals and plants, natural resources and ecosystems, landscapes, as well as the biosphere and the cosmos. Strictly speaking, human beings are, of course, part of nature and it seems somewhat odd to claim that there is a contrast between human beings and non-human nature. However, it seems reasonable to make this distinction because human beings are the only beings (or so humans believe) who are able to reason about the consequences of their actions which may influence the whole of nature or parts of nature in a positive or negative way.

Ideas about the “right” conduct concerning the environment are as old as humankind but the establishment of environmental ethics as an academic discipline dates back to the 1970s

when issues of vital importance emerged, such as the global threat to the natural basis of existence, the growing number of extinct species, the destruction of ecosystems and natural resources, as well as the more recognized dangers of technological inventions---for example, nuclear power, including its radioactive waste, and the new biotechnologies like genetic engineering. The exploitation of the environment was first justified by the religious teachings of the Old Testament (such as the stewardship of the environment in the Bible) and, during the secular period of the Enlightenment. In the non-Western context, the idea of respect for and valuing nature is more prevalent and at least 2500 years old, referring to the general teachings of Hinduisn and Buddhism. Of course, contemporary environmentalists, particularly feminist ethicists and supporters of the idea of natural aesthetics, have refined the criticism of the traditional view by claiming that animals and nature are not valueless but deserving of moral protection.

It is possible to make the following broad distinctions regarding environmental ethics. Environmental ethics is commonly divided into two distinct areas: (i) anthropocentrism (human centred environmental ethics) and (ii) non-anthropocentrism (Eco-centred environmental ethics). ***Anthropocentric approaches*** **such as virtue ethics and deontology stress the particular human perspective, and claim that values depend on human beings only**. Values are relational and require a rational being, hence animals and non-human nature are not *per se* objects of morality, unless indirectly, by virtue of a surrogate decision maker. According to the anthropocentric view, only (rational) human beings deserve moral protection although one should respect and protect nature either for the sake of human beings (instrumental view) or for the sake of nature itself (non-instrumental view).

Anthropocentrism is faced with the *objection of speciesism*, the view that the mere affiliation to the species of Homo sapiens is sufficient to grant a higher moral status to human beings in comparison with animals. There are strong views against this position.

*Non-anthropocentrism* (Eco-centred) mainly consists of three main branches: (1) pathocentrism, (2) biocentrism, and (3) ecocentrism, which can be further divided into an individualistic and holistic version. All non-anthropocentric approaches share the common claim that there are "objective" or more straightforward naturalistic values which are non-relational (intrinsic) and do not presuppose rational human beings. Nature (including animals) itself is valuable, independently of whether there are any human beings or not (non-instrumental view), even though one has to acknowledge the fact that many arguments about intrinsic value also have instrumental underpinnings.

Supporters of *pathocentrism* argue that all *sentient* beings deserve moral consideration and protection, equally/egalitarian or non-equally/non-egalitarian with reference to human beings. Adherents of *biocentrism* claim that all beings should be part of the moral community. Finally, supporters of *ecocentrism* argue that the whole of nature deserves moral protection, either according to an individualistic or holistic approach.
If individualistically, all "things" in nature are bearers of moral values and are of equal moral worth.

**Environmental Concerns in Biotech**

Debates about the commercial introduction of GM plants in some parts of the world have led to questions about their potential impact on the environment unless necessary safeguards are taken into account. However, it is to be noted that even conventional agriculture has impact on the environment and this has to be taken account of in discussing environmental impact of biotechnology / GM. The principal environmental concerns related to agricultural biotechnology include

*Transgene Escape toWild-TypePlants.* There is a potential risk that the GM plants may hybridize (or cross-breed) with sexually compatible or related wild-type species. This may have an impact on the environment through the production of hybrids and their progeny.This is already known to have happened with some GM plants particularly squash in parts of America.

*GM may confer Selective Advantage to Plants in Natural Environments leading to Generation of Superweeds.* The concern of gene flow from GM plants to weedy relatives via pollination is quite intense. It is considered that the transfer of encoded characteristics to weed species could potentially give them a selective advantage, consequently leading to the generation of "superweeds." Moreover, the newly introduced traits may make a plant, especially herbicide tolerant plant, more persistent or invasive (weedy) in agricultural habitats. It is, however, pertinent to note that the risk of gene transfer to weeds is similar with both conventional and GM plants and is not contingent on how these genes have been introduced into plants. Such a risk of gene flow has always existed since the advent of modern plant breeding, and this can occur wherever possible. Besides studies tolerance to particular herbicide can often develop by evolution from within the weed gene pool even in

the absence of gene flow from herbicide-tolerant plants. The transfer of novel genes from transgenics (or even conventionally bred plants) to weeds depends on the nature of the novel gene and the biology and ecology of the recipient weed species. Furthermore, the transfer of herbicide tolerance gene is unlikely to confer any competitive advantage to hybrids outside agricultural areas. It is comforting to recognize that there is no proven evidence of enhanced persistence or invasiveness of GM plants and no major superweeds have developed so far.

*Effect on Nutritional Composition of Plants.* It is speculated that the nutritional composition of GM products may be affected in GM plants. Another concern is that the transgenes from animals (obtained from fishes, mouse, human, and microbes) introduced into GM plant for molecular farming may pose a risk of changing the fundamental nature of vegetables.

*Mixing Genes from Unrelated Species (Interbreeding).* The public is worried about the risk that the GM plants can spread through nature and interbreed with natural organisms, thereby contaminating "non-GM" environments. This would in turn affect the future generations in an unforeseeable and uncontrollable way. Such worries, however, ignore the history of plant breeding and the existing overwhelming sequence similarity of genes across kingdoms.

*Development of Tolerance to Target Herbicide.* It is viewed that the repeated use of the same herbicide in the same area to remove weeds amongst genetically modified herbicide resistant crops (HRCs) (tolerant to single herbicide) will exacerbate the problem of herbicide-tolerant weeds. Another matter of concern relates to the plants carrying different herbicide tolerance genes to become multiply tolerant to several herbicides by pollination between adjacent plants. The development of multiple tolerances in "volunteer" crop plants (from seeds remaining viable in agricultural soil) may also exert an impact on the environment by necessitating the use of less environment-friendly herbicides by the farmers. On the other hand, the proponents believe that herbicide resistance develops due to excessive application of herbicide and is not exclusively associated with gene transfer from genetically modified HRCs. Thus, the pressure on weeds to evolve resistant biotypes has been reported to be pronounced with the excessive application of herbicides such as glyphosate, sulphonylureas, and imidazolinones.

*Sustainable Resistance in Insect Pests.* It is possible that the widespread use of disease-resistant GM plants may lead to the evolution of several insect pests that are resistant to pesticides for the pattern suspected for herbicides. For example, *Bt* crops may develop resistance to *Bt* biopesticide, a permitted biopesticide successfully used by organic farmers in integrated pest management (IPM) programs. There is to date no reported evidence of insect resistance to *Bt* crops under field conditions although *Bt* resistant insects (e.g., cotton budworm and bollworm) have been observed in areas where *Bt* biopesticides are sprayed on crops. It has been a matter of concern that the development of such resistance may lead to the loss of the potential of the *Bt* biopesticide, which may in turn make it necessary for organic farmers to resort to less environmentally acceptable chemical pesticides. Therefore, proper resistance management strategies along with this comparatively newer technology are imperative. The most widely used is the 'high-dose refuge' strategy designed to prevent or delay the emergence of Bt toxin-resistant insects.

*Harm to Non-target Organisms.* Non target effect, that is, undesirable effect of a novel gene (usually conferring pest or disease resistance) on "friendly" organisms in the environment, is another concern related to GM plants. As many non target microbes harbor on plant surfaces or some insects harbor on flowers, it becomes quite challenging to target the insect resistance gene product to appropriate plant tissues and hence kill pests without exerting any adverse effect on friendly organisms such as pollinators and biological control agents. This is particularly difficult where the benign or beneficial organism is related and physiologically similar to the pest to be targeted. One of the most significant studies of nontarget impacts of GM plants has been the killing of monarch butterfly in the United States by Bt insecticidal proteins. It should, however, be noted that the pesticidal sprays used on *Bt* or non-*Bt* corn may be more harmful to the monarch butterfly as compared to *Bt* corn pollen. Thus, in evaluating the use of *Bt* crops and the possible environmental damage caused, it is important to take into account the environmental damage caused by the use of pesticides in agriculture generally. It is argued that millions of birds and billions of insects, both harmful and beneficial, are killed each year due to excessive use of pesticides. It is, however, suggested that the scale and pattern of use may mitigate the effects of *Bt* on nontarget populations. Furthermore, when toxins are produced within plant tissues, nontarget organisms are exposed to amuch lesser extent than with spray applications because only those organisms which feed on the plant tissues come into contact with the toxin. Harmful effect of *Bt* toxin residues in the soil after harvest of the GM crop on soil invertebrates has been another matter of concern.

An investigation of the effect of *Cry1Ab* released from the roots and crop residues on soil organisms revealed the presence of toxin in the guts and casts of tested earthworms. There was, however, no significant difference in their mortality or weight. Moreover, no difference in the total number of other soil organisms (including nematodes, protozoa, bacteria, and fungi) between the soil rhizosphere of *Bt* and non-*Bt* crops was detected.

*Increased Use of Chemicals in Agriculture.* On one hand, the transgenes conferring herbicide resistance have been criticized because these would maintain, if not promote, the use of herbicides and their attendant problems. Similarly, there is a concern that the insect-resistant and disease-resistant GM plants will increase the application of insecticides and pesticides, respectively. On the contrary, reports demonstrate that there is no significant change in the overall amount of herbicide use in the United States since the introduction of GM soybeans. An analysis by soybean growers at the United States has shown that $7.2 millions of other herbicides were replaced by $5.4 millions of glyphosate. This substitution, thus, resulted in the replacement of highly toxic and more persistent herbicides with that of glyphosate. Furthermore, it has been reported that herbicide tolerant oilseed rape eliminates the use of >6,000 tons of herbicide in the growing season.

*Loss of Biodiversity.* The public has long been worried about the loss of plant biodiversity due to global industrialization, urbanization, and the popularity of conventionally-bred high-yielding varieties. It is speculated that the biodiversity will be further threatened due to the encouraging use of GM plants. This is because development of GM plants may favour monocultures, that is, plants of a single kind, which are best suitable for one or other conditions or produce one product. Further, the transformation of more natural ecosystems into agricultural lands for planting GM plants is adding to this ecological instability. Another point of concern is the loss of weed diversity that may occur due to gene flow from HRCs to weeds. It is argued that because the currently available HRCs confer tolerance to broad-spectrum herbicides such as glufosinate and glyphosate, their extensive use may shift the diversity of weeds in agricultural habitats. However, weeds exhibit considerable plasticity and adapt to a wide range of cultivation practices. Experience with conventional agriculture has shown that weed species composition varies within the same crop among different fields and at different times of year. Thus, weed population shifts are natural ecological phenomena in crop management and should not be viewed as exclusive to GM plants.

*Unpredictable Gene Expression.* It is speculated that the random gene insertion, transgene instability, and genomic disruption due to gene transfer may result in unpredictable gene expression. Such a risk is, however, unlikely to be unique to GM plants or of any significance considering our current knowledge of genomic flux in plants.

*Alteration in Evolutionary Pattern.* Plants adapt to the fluctuations in the environment through changing their genes and developing better races called "evolved races." These mutations, however, occur at a very low frequency (i.e., one in about 109/gene/generation). It is hypothesized that the cultivation of GM plants by the farmers at an increasing rate throughout the world may change the evolutionary pattern drastically. Another concern is the evolution of non-GM plants through hybridization with GM plants.

*Loss of Ecosystem in Marginal Lands.* As new plants are introduced mainly to marginal lands, loss of natural ecosystems in these areas has also been a matter of concern. This is not GM specific even though it is considered that capacity conferred by GM may extend this.

*Contamination of Soil and Water.* It is also sometimes argued that the widespread introduction of HRCs will increase the use of herbicides, which will in turn contribute to the contamination of soil and ground water. However, this is not the case. The cultivation of HRCs in the United States has been reported to facilitate zero-till agronomic system, which contributes to a reduction in soil erosion. The release of *Bt* toxin into the soil after harvest of *Bt* crops is also viewed as a risk factor associated with the cultivation of *Bt* crops. It has been found that *Bt* toxins remain active in soil; however, it is not necessarily an environmental hazard because *Bt* toxins must be ingested and affect only selected groups of insects. Moreover, the potential leaching rate of *Bt* toxin is reduced due to its binding and adsorption on clay particles.
(see Verma S.R 2013. Genetically modified plants: Public and scientific perception. ISRN Biotechnology V 2013)

Ethical concerns related to environmental impact of biotech centre around the belief that "GMOs are novel products which have the potential to reduce or change nature's biodiversity or upset the balance of nature perhaps in unintended ways".

These are related to:

- Transgene escape to wild-type plants and horizontal transfer leading to new disease agents
- GM Plants having selective advantage in the environment leading to generation of super-weeds
- Mixing of genes from unrelated species- 'crossing of species boundaries'
- Development of tolerance to herbicide/pesticides & increasing use of herbicides / pesticides and damage or depletion to dependent wildlife
- Resistance to insect pest
- Harm to non-target organisms
- Loss of biodiversity (crop and wildlife)
- Loss of genetic diversity within crops
- Unpredictable gene expression and flow ('genetic pollution')
- Alteration in evolutionary pattern
- Loss of ecosystem in marginal lands/ conversion of such lands to agriculture
- Agricultural intensification

Contamination of soil and water

**Environmental Ethics in Biotech**

Environmental ethics draw from human understanding of *Nature* and *Creation* and is usually either *Human Centred* or *Eco-Centred*

- Human centred Environmental ethics: the environment is valued for what it can provide for humans;
    - it is protected so that the resources it provides will be available for current and future generations.
- Eco centred Environmental ethics: The environment is valued because it has intrinsic value;
    - it was so created;
    - natural order;
    - God made it so, and humans are only custodians

Both approaches recognise that humans are part of the biosphere & need to protect the environment to be able to continue to exist sustainably

**Human centred Environmental Ethics**

- Humans depend on the environment for life and quality living
- Quality living depend on biodiversity
    - Humans derive pleasure from living alongside elements of the natural world or knowing that they exist
- The delicate balance of the ecosystem my be upset by the introduction of new organisms
- The environment should be preserved to provide for the sustenance of this and future generation

**Eco-centred Environmental Ethics**

- Eco-centred environmental ethics arguments are more intrinsic than the human centred one and often are driven by religious beliefs
    - Nature has value for itself because it is there
    - We should not damage other species unless it is absolutely necessary for human survival (not luxury)
    - Nature has life so has some value
    - God created the world and so has value as created
        - (humans are stewards not owners of the planet)
    - Less convincing is the argument that living organisms that comprise the environment have rights
    - Intrinsic arguments raise issues of unnaturalness of biotechnological interference with the biosphere

**Potential Benefits of Biotech to the Environment**

- Reduction of inputs; increased yield due to herbicide tolerant and insect resistant crops
    - Reduction in the water use
    - Reduction in pesticide and herbicide use
- Improved agronomic practice; direct sowing in unploughed land (herbicide tolerance and efficient weed control)
    - Reduction in moisture loss
    - Marginal increases in length of growing season
    - Control of erosion in erosion prone soils
    - Climate improvement
- Potential for reclaiming marginal land for wildlife as a consequence of improved yield from GM crop use

**Module 5 Unit 3: Ethical issues in the uptake of Biotechnology**

**Lecture 3**: **Framework for analysing ethical issues (2hrs)**

**Learning Outcomes**

**Students & Lecturer are expected use the standards derived from the ethical theories explored in 1c (Consequentialism; Deontology; Virtue & African Moral Theory) to analyse the**

- **Ethical issues raised in crop biotechnology**
- **Ethical issues raised in animal biotechnology**
- **Ethical issues raised in environmental biotechnology**

**In the process the student will be able to develop their own points of view in ethical**

**What ethical issues are at stake?**

In respect **plant and animal** biotechnology the issues relate to the technology being:

- Blasphemous
- Unnatural
- Disrespectful
- Unsafe and
- Has Negative Socio-economic consequences (in particular for rural farmers; this relates to fairness/ unfairness in benefit distribution)

In respect of the **environment** the issues relate to:

- Escape of transgene to Wild-type plants/ horizontal gene transfer leading to new diseases
- GM Plants with selective advantage leading to super-weeds
- Crossing of species boundaries
- Herbicide /pesticide damage to dependent wildlife and non-target organisms
- Development of resistance in insect pests
- Increased used of herbicides and pesticides
- Loss of biodiversity (crop and wildlife) and genetic diversity
- Unpredictable gene expression and flow (‘genetic pollution’)
- Alteration in evolutionary pattern
- Loss of ecosystem in marginal lands/ conversion of such lands to agriculture
- Agricultural intensification
- Contamination of soil and water

**Response/ approaches to handling ethical issues raised by biotechnology**

Effective discussion of the issues raised above can be best achieved by keeping eye on predominant concern:

## Guide to considering the key questions

In considering ethical questions it is important to consider widely recognised key considerations that will guide choices. These are:

- Respect for persons
- Minimizing harms while maximizing benefits
- Fairness

These form the bases of the framework for ethical analysis (see: module 1 C; Utilitarianism, Deontology and Virtue) and ethical decision making.

- Uncertainty/ precautionary principles
- Consent, labels and choices

These may be discussed on the bases of methods in ethics as developed in unit 1c

**Guide to analysing ethical issues related to crop, animal and environmental biotech**

Ethical issues related to crop, animal and environmental biotechnology may be analysed by use of the ethical frameworks that have been studied in unit 1 as presented in the table. Reference should be made to the Table below for guidance. Attempt should be made to explain each ethical issue in the light of the prescriptions of each ethical theory or framework. How does consequentialism explain, handle or manage the belief that application of biotechnology to improve crops is blasphemous? Which biotechnologies can possibly be considered as blasphemous? Applying the same procedure, it is possible to attempt explain or manage other ethical issues on the basis of different frameworks. It is to be noted that not every framework has explanations about every ethical concern.

| Ethical Issues | Ethical Framework | | | |
|---|---|---|---|---|
| | Consequentialism | Deontology | Virtue Ethics | African Moral T |
| Blasphemous | | | | |
| Disrespectful | | | | |
| unfair | | | | |
| Loss of biodiversity | | | | |
| Super weed | | | | |
| Super pest | | | | |
| Genetic Pollution | | | | |
| Others | | | | |

*Use slides 64-66 of the lecture for full information to interrogate this section; Refer to unit 1 lectures 3 & 4 for support and basic information*

**Module 5 Unit 3: Ethical issues in the uptake of Biotechnology**

**Lecture 4: Elements of Strong and Elements of Weak Justification (1h).**

Learning Outcomes

The aim of this lecture is to guide the student to understand that sound justification in bioethics entails paying attention to the key questions and core ethical considerations embedded in the framework deployed in 'Lecture 3' above and Unit1 lecture 3 & 4.

A recap on Ethics and Bioethics (aspects of Unit 1)

Why teach bioethics & bioethical analysis?

- **Advance students' science understanding.** Teaching bioethics can serve as a way to teach science to students who otherwise might not be engaged with the subject:- science society interface and consideration for real world situation/ reasoned positions.
- **Prepare students to make informed, thoughtful choices.** Studying bioethics is a way to deepen students' understanding of biotech and its impact on society.
- **Promote respectful dialogue among people with diverse views.** Engaging in bioethics discussions helps develop students' ability for reasoned dialogue, especially among people with different perspectives/ backgrounds. It also encourages deep thinking about choices from a variety of viewpoints and interests, thus facilitating respectful discussions of potentially contentious issues.
- **Cultivate critical-reasoning skills.** Bioethics activities emphasize the importance of justification, a process of giving reasons for views

**Basic concepts in Bioethical analysis**

Ethical analysis requires clarity which can be gained through critical consideration of four key questions:

- What is the ethical question?
- What are the relevant facts?
- Who or what could be affected by the way the question gets resolved?
- What are the relevant ethical considerations?

- Providing comprehensive answers to these questions enable ethical decision making which may not be the consensus but can recognise all relevant considerations and take account of different viewpoints based on careful reasoning.
    - The bottom-line is to encourage provision of justifications for individual decisions.
- These questions need not be sequential.

Guide to considering the key questions

What is the ethical question?

What are the relevant facts?

Who or What could be affected by the way (ethical) question gets resolved?

What are the relevant ethical considerations?

Building and assessing Justifications

(For understanding of this section please consult "NIH-Exploring Bioethics)

**References and Further Reading:**

**https://www.nih.gov/news-events/news-releases/nih-releases-innovative-approach-exploring-bioethics-new-curriculum-supplement**

**https://science.education.nih.gov/supplements/nih9/bioethics/guide/masters.html**

**https://science.education.nih.gov/supplements/nih9/bioethics/guide/teaching.html**

*Paarlberg* R.L. (2000) Governing the GM Crop Revolution Policy Choices for Developing Countries: *Food, Agriculture, and the Environment Discussion Paper 33.* Washington D.C. International Food Policy Research Institute

Roger Straughan and Michael Reiss Ethics, Morality and Crop Biotechnology. UK, Biotechnology and Biological Sciences Research Council

Roger Straughan Ethics, Morality and Animal Biotechnology. UK, Biotechnology and Biological Sciences Research Council

Cooke, J.G. and Downie R. (2010) Richard DownieAfrican Perspectives on Genetically Modified Crops Assessing the Debate in Zambia, Kenya, and South Africa; A Report of the CSIS Global Food Security Project.

Rigaud, N. (2008) *Biotechnology: Ethical and social debates.* OECD International Futures Project on "The Bioeconomy to 2030: Designing a Policy Agenda"

http://www.accessexcellence.org/RC/AB/IE/bioethics.php

Caro, S., Sachez, E., Ragucci M. and Vassarotti, A (2002) Ethical, Legal and Socio-economic aspects of Agriculture, Fisheries and Food Biotechnology. European Commission

Obembe, O.O (2010) The plant biotechnology flight: Is Africa on board? African Journal of Biotechnology 9: 4300-4308

Gbadegesin, S. (1993) Bioethics and Culture: An African Perspective *Bioethics* 7 *2/1 257-262*

Devos, Y., Maeseele, P., Reheul, D., van Speybroeck, L., and de Waele D (2008) Ethics in the Societal Debate on Genetically Modified Organisms: a (re)quest for sense and sensibility. Journal of Agricultural and Environmental Ethics 21: 29–61

Look at *Pocket K* series for interesting articles on various aspects of Biotechnology ethics

http://science.education.nih.gov/supplements/nih9/bioethics/guide/teaching.htm

Thompson, P (2007) Food Biotechnology in Ethical Perspective (2nd Edition) Dordrecht, The Netherlands: Springer 340pp

Nuffield Council on Bioethics (1999) Genetically modified crops: the ethical and social issues. London; Nuffield Council on Bioethics 171pp

Verma, S.R. (2013) Genetically Modified Plants: Public and Scientific Perceptions. ISRN Biotechnology Volume 2013, 11pages http://dx.doi.org/10.5402/2013/820671

Hoban, T.J. (2004) Public Attitudes towards Agricultural Biotechnology ESA Working Paper No. 04-09. The Food and Agriculture Organization of the United Nations

Albert Weale, A. (2010) Ethical arguments relevant to the use of GM crops. New Biotechnology 27 (No. 5) 582-587