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Editorial address:

Prof. Darryl Macer, Director, Eubios Ethics Institute,
c/o Center for Ethics of Science and Technology,
Chulalongkorn University, Faculty of Arts, Chulalongkorn
University, Bangkok 10330, Thailand
Email: darryl@eubios.info

Editorial: Animals, Energy & Bioethics

This issue features a number of articles on environmental ethics issues, including 3 papers on animal welfare. Taka Fujii discusses some of the considerations about livestock euthanasia around the Fukushima No. 1 Nuclear Power Plant, in a paper presented at the KBRT6. The fate of many animals after disasters is a topic that could be considered for future policy. Radioactive contamination of wild animals which move and interbreed with other animals outside exclusion zones is another interesting topic, as it may lower genetic fitness of endangered animals. There is some data from Chernobyl that shows more animals thriving after humans are removed, but long term studies would be useful. Should farm animals be killed or left free to roam and take their chances at survival?

A S M Anwarullah Bhuiyan presents a general review of animal biotechnology, with some of the ethical principles that can be applied. K. K. Verma gives examples of how climate change will impact animals and humans. Abhik Gupta presents some disturbing data on the actual experiences of farmers who tried to make biodiesel from *Jatropha curcas*, which has been widely promoted as a green energy. A.J. Thatheyus et al.,

examine some ecological effects of dams. The ethics of energy technologies project is continuing in UNESCO Bangkok, and two recent completed reports are on Ethics and Biodiversity, and Energy Equity and Environmental Security. Other reflections on the ethics of climate change continue in draft reports. In October conferences were held in India on Indian philosophies and the development of the Ethical Repository of World Views of Nature, which is developing.

The Ethical Issues of Biobanks in China is reviewed by Yanguang Wang, including a number of biobank examples which are growing. Carter Reitman and Ann Boyd discuss more theoretical issues in Research Principles as Clashing Phantoms, and Francisco D. Lara presents a review in Ethical Analysis of the Embryonic Stem Cell Controversies.

Please renew your Asian Bioethics Association (ABA) subscriptions for 2013! New articles are welcome, and this issue is being printed with the first issues of 2013 on medical ethics issues.

It was a pleasure to meet many readers at the 13th Asian Bioethics Conference in Kuala Lumpur, and the 14th Asian Bioethics Conference will be held in Chennai, India, 19-23 November 2013. The theme is on Ethics in Emerging Technologies to make lives better together, and there are also two other conferences being held in the second half of the year in Japan, and other places around Asia-Pacific.

– Darryl Macer

Considerations about Livestock Euthanasia around the Fukushima No. 1 Nuclear Power Plant

- Taka Fujii, M.D., Ph.D.
Saga University, Japan
Email: likes_rahmens@yahoo.co.jp

Abstract

This paper reports about some of the effects on livestock following the nuclear meltdown of the Fukushima No.1 nuclear power plant. Most livestock were left behind in contaminated area, and Japanese government prompted prefectural governor of Fukushima to euthanize livestock living within a 20 km radius of the plant. This issue must be considered through an animal welfare approach and a biocentric approach.

Damage to farm animals from the meltdown at Fukushima No.1 Nuclear Power Plant

Tohoku district suffered a great loss from the Great East Japan Earthquake on 11 March 2011. More than 20,000 human lives were lost or went missing. Tohoku district is a geographical area of Japan occupying the northeastern portion of Honshu, the largest island of Japan. The district consists of 6 prefectures: Akita, Aomori, Fukushima, Iwate, Miyagi, and Yamagata. There were some dangers to human security brought about by natural disaster and also by human disaster amidst the confusion (including even a few cases of robbery). A large-scale radiation leak occurred at the Fukushima No.1 nuclear power plant due to the earthquake and multiple tsunamis, another example of human disaster.

Not only humans but also animals sustained serious damage from these disasters. This paper considers two types of domestic animals (Pet Animals and Farm Animals) adversely affected by radioactive contamination. Some of the pets are sheltered by animal protection groups under the Pet Rescue Acts. Some of them returned to their owners and some were taken in by new families.

Animals are classified according to feeding state in Japanese Animal Law. There are four classes: Pet Animals, Display Animals, Farm Animals, and Experimental Animals. Pet Animals are kept for companionship or pleasure at home or school. Like human care, care for Pet Animals is provided for each individual. Care for Pet Animals should aim to keep, recover, and improve their health.

Farm Animals are kept for industrial use in farms or factories. Livestock are included in this category. Laws on Farm Animals are under the jurisdiction of the Japanese Ministry of Agriculture, Forestry and Fisheries. In regard to Farm Animals, policies are established not for animal's QOL (quality of life) but for economically producing delicious meat products for humans. This kind of care does not aim to help individual animals, but to manage the health of all livestock as an entire economic production system. For example, individual disease-infected animal usually is not treated but is decided by humans to be killed to maintain the health of a group.

The town of Namie is located within 10 km of the nuclear power plants. After March 2011, most farms were affected by radiation. Farmers have left their livestock behind. Many cattle died from starvation (April 2011).¹ Some dead bodies still lay neglected months later in January 2012.² Some farmers consider livestock as their family.³ It was a painful choice for farmers.

All animals left behind can be called "non-human-fed Animals." Non-human-fed Animals are no longer kept by humans because of abandonment or escape. The Animal Law and Veterinary Practice Act of Japan does not include these animals under its protection and veterinary treatment. Mainly, care for non-human-fed

Animals is provided by groups of animal philanthropists outside the framework of these laws. Some people work for non-fed Animals including killing stray dogs, cats, and other sick animals. This type of work has its roots in more radical anthropocentrism. However, there are some effects of Animal Welfare regarding killing methods such as not to cause unnecessary pain or to treat them cruelly.

In this nuclear meltdown case of Fukushima, animal philanthropists have helped some Pet Animals. However, they cannot really extend protection to livestock because of high costs and lack of manpower.

In addition, almost every Wild Animal has been exposed to radiation. Wild Animals are living in the natural environment. They do not depend on humans, though they are affected by human activity. One of the particular concerns in this nuclear meltdown case is biological concentration of radioisotopes, centering on marine organisms.

On 12 May 2011, former Prime Minister Naoto Kan instructed the prefectural governor of Fukushima to euthanize all livestock, with the consent from farmers, living within a 20-kilometer radius of the plant. According to Yukio Edano (the chief cabinet secretary at the time), this judgment was based on the Disaster Special Measures Law.⁴ In truth, however, there is no law governing the treatment of farm animals in time of nuclear accidents.

Treatment of livestock at the Chernobyl power plant disaster

For comparison, Chernobyl power plant disaster (26 April 1986) must be considered.⁵

Early stage after the disaster (May–June 1986):

During evacuation of a 30-kilometer radius of the plant, 50,000 cows, 3,300 sheep, and 700 houses were evacuated. However, many of livestock were killed due to lack of feed; 95,500 cows and 23,000 pigs were killed and buried in the ground or frozen. Contamination level of livestock was not determined.

Middle stage after the disaster (June 1986–1989):

Non-polluted feed was given to livestock. However livestock suffered from shortage of feed. The government prohibited grazing on the polluted pasture.

Biocentric Approach

I would like to offer a tentative recommendation based on the perspective of Biocentrism. Biocentrism is a position supporting the following statements⁶: (1) All living beings are the subject of value. Valued objects for living things and the entity of that living thing are moral objects; and (2) a "Person" has a responsibility to be a subject of moral judgment and consideration.

James Sterba introduced 5 principles of biocentrism (principle of defense, nondefense, preservation,

¹ <http://en.rocketnews24.com/2011/04/11/fukushima-cattle-on-abandoned-ranch-starve-to-death-no-sign-of-owners-return/>

² Takashi Morizumi's photo-blog (<http://mphoto.sblo.jp/article/53055583.html> (11 January 2012))

³ Kishida, S. and Macer, D. (2003) Peoples' Views on Farm Animal Welfare in Japan, in *Asian Bioethics in the 21st Century*. Eubios Ethics Institute.

(<http://www.eubios.info/ABC4/abc4335.htm>)

⁴ Prime minister of Japan and His Cabinet, chief cabinet secretary's press release

(http://www.kantei.go.jp/jp/tyoukanpress/201105/12_p.html)

⁵ Ayaka Hinai (2011) Chernobyl genpatsu jiko go no dojou no jouka to juumin heno higai [Post-Chernobyl nuclear disaster: Decontamination of soil and damage suffered by its residents] <http://www.machida2.co.jp/genpatsu/chernobyl.pdf>

⁶ Taka Fujii (2010) Restructuring of Biocentrism as a Bioethical Theory. (doctoral thesis.)

nonaggression, and rectification) and he defined them as follows⁷:

1. Principle of defense

A principle that permits actions in defending both basic and non-basic needs⁸ against the aggression of others, even if it necessitates killing or harming the others unless prohibited.

2. Principle of nondefense

A principle that prohibits defending non-basic needs against the aggression of others that is undertaken as the only way to meet basic needs, if one can reasonably expect a comparable degree of altruistic forbearance from those others.

3. Principle of (aggression for) preservation

A principle that permits aggression when necessary against the basic needs of others for the sake of basic needs unless prohibited.

4. Principle of nonaggression

A principle that prohibits aggression against the basic needs of others either (1) to meet non-basic needs, or (2) even to meet basic needs if one can reasonably expect a comparable degree of altruistic forbearance from those others.

5. Principle of rectification

A principle that requires compensation and reparation when the other principles have been violated.

Appeals from the Biocentric point of view

There are 4 appeals possible from the biocentric point of view (listed in the order of importance): (1) the livestock breeding must be reconsidered. Especially, meat eating and restricting the freedom of livestock animals must be denied, if these needs are not basic needs for human. (2) Even if meat eating were human basic needs, we must not violate the need of livestock until they clash. We should not establish any dangerous system that violates basic needs of living things, for example, a system that allows nuclear power plants to be built. (3) Humans have duty to consider the needs of livestock. (4) The judicial classification system (such as Pet Animals and Farm Animals) is insignificant. All animals must be treated as equal moral objects.

The possible recommendations from a Biocentric point of view are very similar to that of an Animal welfare approach. Animal welfare aims to prevent the suffering or inhumane killing of animals as much as possible. The Five Freedoms listed below are international standards of animal welfare.⁹

1. **Freedom from hunger and thirst** - by ensuring access to fresh water and a diet to maintain full health and vigor.

2. **Freedom from discomfort** - by providing an appropriate environment including shelter and a comfortable resting area.

3. **Freedom from pain, injury, and disease** - by means of prevention or rapid diagnosis and treatment.

4. **Freedom to express normal behavior** - by providing sufficient space, proper facilities, and company of animal's own kind.

⁷ James P. Sterba (1998) "A Biocentrist Strikes Back" In *Environmental Ethics*, Vol. 20, winter, pp. 363-368.

⁸ Basic needs are those needs related to one's own survival.

⁹ Farm Animal Welfare Council (<http://www.fawc.org.uk/freedoms.htm>)

5. **Freedom from fear and distress** - by ensuring conditions and treatment which avoid mental suffering.

Now we can offer actions based on 5 freedoms from the point of view of animal welfare. Livestock must be free from pain caused by starvation, injury, disease, fear, or distress. They must be able to receive decontamination as with pet animals and to live out their days. We should euthanize only dying, suffering, and irrecoverable animals. Also, government should prepare a special law for the treatment such as the law for Foot and Mouth Disease that occurred in Miyazaki prefecture.¹⁰ We simply have laws concerning euthanasia of non-human-fed animals and infected animals.

At the same time, we must consider issues from biocentric perspective. It may require more time.

An Ethical Appraisal of Animal Biotechnology

- A S M Anwarullah Bhuiyan, MA (philosophy), M.Phil (Moral Philosophy), Masters in Applied Ethics (Linköping University, Sweden)

Associate Professor, Dept. of Philosophy, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh

Email: bhuiyan_phil@yahoo.com

1. Introduction

In the last century, a number of scientific discoveries such as information technology, genetic engineering and biotechnology marked the arrival of a new era of scientific advancement. Biotechnology has a long history. Since the beginning of the civilization when human beings learned the art of 'planting crops' and 'breeding animals', they also learned, at the same time, how to ferment fruit-juice into wine, beer, and cheese, how to convert milk into yoghurt, and how to make spongy-bread by using bacteria and yeast. All these activities are the nascent stage of biotechnology. During the last few decades, biotechnology has ushered into various technologies; some of these are: (i) bio-processing such as using in vitro manipulation of cells, (ii) recombinant DNA technology, and (iii) monoclonal antibodies. One of the main objectives of biotechnology is to invent new ways of producing adequate food for the world. This article endeavors to reach the conclusion that biotechnology, specially the field of animal biotechnology, has got a variegated splendor. In this article, the following issues are addressed: is modern animal biotechnology compatible with the norms of animal welfare, environment, and public health? In order to spell out the answer to this question, this article will explore two lines of ethical controversy — intrinsic and extrinsic arguments. Finally, through the analysis, this article will

¹⁰ The Japan foot-and-mouth outbreak occurred in 2010 in Miyazaki prefecture, affecting cattle, swine, sheep, and goats. About 290,000 livestock were put down. After a similar outbreak that occurred in 2000, Japanese government established Specific Domestic Animal Infectious Disease Quarantine Guideline on Foot-and-mouth Disease in 2004. In 2011, revised guideline was published as a result of outbreak in 2010.

come to the conclusion that none of the ethical tools or theories can materially represent the problems to solve the ethical debate about animal biotechnology that will satisfy everyone.

2. Ethical Challenges of Animal Biotechnology: Pros and Cons

In order to develop micro-organisms, improved plants or animals, and to modify food-products, biotechnologies have been used in a wide range of production. This technique is used for transgenic animal's production, commercial products, food production, plant tissue culture, DNA profiling/finger printings, animal tissue culture, pollution control, to safe plants and animal's extinction, prevention-diagnosis, and cure of diseases. According to its use, different kinds of biotechnologies can be mentioned as following: **a.** Industrial biotechnology, **b.** Environmental Biotechnology, **c.** Biotechnology as Human Application, **d.** Health Biotechnology and **e.** Agricultural Biotechnology. All these types of biotechnology are not my area of focus. Rather, I will focus on animal biotechnology.

Different kinds of technologies have been improved in the area of biotechnology. All of these technologies have given a great opportunity to human beings. Biotechnologies have made it possible to produce more nutritious food and medicine and also to develop a way for growing more food in saline water, nearly drought land, and in stressed conditions. Despite these contributions of animal biotechnology, different controversies have been raised in this regard. All of these bring forth different ethical challenges. During the last few decades there have been different types of arguments are discussed in this regard. Critics have generated different arguments while opposing this technology, which may conveniently be divided into two kinds: (1) intrinsic arguments and (2) extrinsic arguments.¹¹

2.1 Intrinsic Arguments against Animal Biotechnology

Intrinsic arguments against biotechnology maintains that biotechnology is "objectionable in itself"¹². And extrinsic argument focuses on the "allegedly harmful consequences of making GMOs"¹³. In this sense, animal biotechnology is ethically problematic because "it is unnatural to genetically engineer plants, animals and foods" (Comstock, 2002:76). The argument goes like this, biotechnology is the form of 'redesigning an animal' which is the "Playing with God". (Animals) biotechnologies are also break down the natural species boundaries.

i. The Argument for Playing with God

The argument of Playing with God is based upon the concept of 'God's will' and on the relationship among God, nature, animals, and human beings. It is found in the *Bible*. To some extent, this argument is the adherent

version of Christianity (Kaiser, 2005:77). C.A.J. Coady (2009) uses the term in a religious sense. He thinks that the view that God himself sets out a plan and makes designs for the universe and human beings is being assigned to observe it. God as an omnipotent and omniscient being, has set out a specific 'roadmap' for the universe, animal kingdom, and nature (Coady, 2009:155-180). But, animal biotechnology tempers the animals' design by inserting a new gene into a species. Thus, in a way (animal) biotechnology breaks down the boundary between the 'realm of God' and the 'realm of humans'.

Is the 'playing with God' argument enough to oppose animal biotechnology? We get responses to such a question in Ronald Dworkin's book *Sovereign Virtue* (2000) in which he argues that in the bio-political context 'the argument for Playing with God' is not 'morally and intellectually honest'. This is not a recent phenomenon to sustain the fight against hostile nature. Human beings, for their necessity and needs, rearrange nature in the way they find it suitable for them. Biotechnology is such a technology that has essentially become a part of human life. Therefore, the argument for Playing with God is not a strong stand to stop biotechnology.

ii. Break-down of Natural Species Boundaries

Recently, a conceptual study, "Ethical Aspects of Agricultural Biotechnology"¹⁴ has shown that any sort of biotechnology is morally unacceptable because of its 'unnaturalness'¹⁵. A report published by the European Commission agrees with the idea that (animal) biotechnology is unnatural. This theory also indicates that the application of biotechnology breaks the natural order of different kinds of species. Something natural is assumed to be valuable and good. But, all kinds of biotechnology or genetic technology temper nature where species boundaries are crossed. The term, 'Natural', is somehow different from the concept 'Unnatural'. The difference can be shown 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".¹⁶

Something, which is natural also means that it is 'normal', 'right', 'appropriate', and 'suitable'. On the contrary, 'unnaturalness' refers to something which is human-made, artificial, or which is dependent upon our interference with the natural world. 'Unnaturalness' has got a broad spectrum in our modern life. For example, most of the food production, animal farming, clothing, and used materials are the result of unnatural interference of nature. 'Naturalness' and 'unnaturalness' can be characterized as 'non-anthropocentric view' and 'anthropocentric', respectively. The anthropocentric view proposes a careful management of resources along with interference of nature. On the other hand, the eco-centric

¹¹ Kaiser. M., 2005. "Assessing Ethics and Animals Welfare in Animal Biotechnology for Farm Production", *Rev. Sci. Tech. off Intl Epiz*, 24 (1), p.75.

¹² Comstock, G., 2000. *Vexing Nature? On the Ethical Case against Agricultural Biotechnology*, Boston: Kluwer, Academic Publishers, p. 76.

¹³ Comstock, 2000: 76.

¹⁴ BABAS, 1999, *Ethical Aspects of Agricultural Biotechnology*, Bioethical Aspects of Biotechnology in the Agro Food Sector, Cambridge Biomedical Consultants, The Hague

¹⁵ AEBC 2002. Agriculture and Environment Biotechnology Commission (AEBC), *Animals and Biotechnology*, AEBC, London. Available in www.aebc.gov.uk/aebc/pdf/aebc0117.pdf, accessed on 5 June 2010.

¹⁶ BABAS, 1999, p.10

view generally holds the view non-interference in relation with nature. The ecocentric view accompanies the view of 'respect for nature', which does not allow any biotechnological tool as a means of the interference of nature. As an anthropocentric means, biotechnology is the viable example of unnaturalness by which natural integrity of species and the species boundaries are breached.

2.2 Is Intrinsic Argument Consistent?

Regarding the intrinsic argument we can explore the following two points at least:

Firstly, the central theme of intrinsic argument is that every species has got its own shape and structure, which it gains in a natural way. Natural diversity refers to the existence of particular characteristics of every species. Some animal biotechnologies such as transgenesis and Xenotransplantation break-down the natural diversity of animals, which is not right way of treating them. In response to this criticism, we can mention here Darwin's theory of evolution. According to this theory, the structure and the phase of every species is not static. According to Darwin (1859), phenotypes of species change from one generation to the other over a long period. Various new types of species arose from the species of the past through a process of gradual change. The period of change might be as long as hundreds or thousands of years or even more than that. Species are also changing their physiological structure, either by natural selection or by their adaptation to the environmental changes.

Sometimes, the course of change in the animal occurs in its inner genetic mapping. Most of the theorists of evolution regard this change as a natural process. The natural change of animals might occur slowly over the years. There is another example we can explicate here. Some of the viruses have capacity to bear genetic materials which are very much helpful for gene transformation to another species. This gene can bring a radical change in the new species. This is a natural process of change as it occurs through biotechnological process. So, the idea that is not based on strong arguments as such a breakdown of natural species has always been occurring in the animal kingdom.

Secondly, sometimes animal biotechnology is considered as unnatural, which is intrinsically wrong. Do we think that in the natural world anything natural is normal or ethical? Regarding this question, we can refer to some of natural phenomena such as earthquakes, cyclone, storm, drought, flood, and many other such natural calamities which usually take place in nature and create an abnormal phenomenon. Although it is described as 'natural' should we consider it as normal or intrinsically good? Of course, we do not consider these as normal phenomena. So, something that is natural or formulated by natural law does not always mean that it is arranged or created by the law of order or in a disciplined way. In this sense, the concept, 'natural' does not mean good or normal as it is attributed by the critics of animal biotechnology.

If we look at the agricultural crops and food by which we live, we can realize that these are the results of biotechnological formulation. The system of production of agricultural crops is the best instance of biotechnology. Even in the animal kingdom naturally and artificially there is a variety of forms of biotechnology. We mould the

nature for our suitable use by applying certain techniques upon it. So, the techniques for processing nature, the techniques for producing crops, and the techniques for creative survival and progress of dwelling are the essential features of our living. In that sense intrinsic argument cannot be a strong defence against the animal biotechnology.

2.3 Extrinsic Argument Against Animal Biotechnology

In the sense of extrinsic argument, animal biotechnology is ethically wrong because of its negative consequences on human beings, animals, and environment. Extrinsic arguments deal with two potential questions: i. Does animal biotechnology violate the criteria of 'animal welfare'? ii. What are the effects of biotechnological application upon the environment?

i. Animal Welfare. Before finding out the answer to the first question, at first, we shall have to make the concept of 'animal welfare' clear. Some of the exponents focus on the physical environment such as shelter and feeding; they also need to measure how the animals are coping with the existent environment.¹⁷ Besides, there are people who think it is important to maintain the psychological status of animals. They are of the opinion that animals have various psychological states such as fear, frustration, and pain, which need to be addressed. It should be taken as part of their primary needs.¹⁸ But, application of animal biotechnology involves such procedures that can cause different types of sufferings for the animals. Peter Singer states about the sufferings that there is no tolerable life for the animals that are in intensive livestock farming. There, throughout the year, animals are crowded in a battery cage, or in the cases of a breeding sow, there they are unable to walk or turn around, there is no way of socializing, sometimes they are thrown out and killed. All these steps are evidences of ill-treatment of animals as these confines them to a limited boundary.¹⁹

ii. Environmental Concerns. A study on 'animal biotechnology and environment' by Krinsky and Wrubel²⁰, claims that animal biotechnologies have got an enormous amount of environmental benefits. They argue that in the traditional milking system more cows give less amount of milk and occupy more agro-land, more cows also produce more slurry and manure. On the other hand, the use of biotechnology is helpful in reducing the amount of land required; thus it can keep the land for non-agricultural purposes. Another study has shown that a genetically modified animal generates 'low phosphorus manure'²¹. Thus, the use of biotechnology turns into a great environmental benefit.

¹⁷ Broom, DM., 1991. 'Animal Welfare: Concepts and Measurements', *Journal of Animal Science*, 69, p.4167-4175.

¹⁸ Duncan IJH., 2002. "Poultry Welfare: Science or Subjectivity?" *Br. Poultry Science*, 43, pp.643:652.

¹⁹ Singer, Peter, 1989. Evidence to Committee, 11 Aug, 1989, Australian and New Zealand Federations of Animals Societies, Evidence, 9470.

²⁰ Krinsky, Sheldon and Wrubel, Roger P., 1996. *Agricultural Biotechnology and the Environment: Science Policy and Social Issues*, Urbana: University of Illinois Press.

²¹ Goloven, S.P., et al., 2001. "Pigs Expressing Salivary Phytase Produce Low-Phosphorus Manure", *Nature Biotechnology*, 19, pp. 741-745)

2.4 Are the Extrinsic Arguments Consistent?

Regarding the concept of 'extrinsic argument', it has been argued that new technologies used in animals cause pain and sufferings in different ways. But, there are also opposite views to it. Animal biotechnology such as cloning or transgenic technique does not necessarily cause pain to an animal. Rather, it reduces the animal's pain. Furthermore, it can be said that in the conventional system of animal breeding an animal experiences severe pain.²² Not only that, the conventional style of domestication also violates 'animal integrity' and 'animal welfare'. For example, in the domestication system, animals are infringed in a limited boundary; its movement is confined to that area, and its feeding and natural requirements are met and determined from the outside. However, to get a balanced life and physiological growth animals need suitable environment where they can grow naturally and smoothly.

[Bio]Technology (whether it is animal or agricultural) is one means of our living today. We cannot deny or oppose it all suddenly. We need to be careful as well as critical in this regard. Therefore, it is an imperative that we select tools for better assessment for evaluating [bio] technology.

3. Concluding Remarks

Throughout our discussion, we have found two different outlooks on biotechnology. On the one hand, it can be said that it has got various and wonderful splendors, which can be enhanced in many different ways. Its enormous contribution to life and it's some particular achievement in the medical sector and in the food varieties has given this technology a tremendous input to human life. We can mention here the following: this (bio) technology has made it possible to save a child from polio by inventing polio-vaccines; it can save life of those people who are affected by infectious diseases; it is also able to provide protein and food at reasonable prices. On the other hand, it should also be mentioned that as a technology it has got a lot of adverse effects upon human health, the environment, and the individual's autonomy. This is why it should be discouraged in every way possible. In this circumstance, where should we stand? Should we ban any kind of practice of animal biotechnology? Or, should we encourage this technology? The ethical concerns involve a broad spectrum of decisions. For example, today biotechnologically developed animals are used for human benefits and purposes. Some particular ethical concerns, specifically animal welfare, animal freedom, and animal integrity, are involved in this issue. Ethical concerns such as the well-being of humankind, food safety, and fair access to the products are connected with the idea of human beings as users of animal biotechnology. Environment is an important issue of animal biotechnology. In this arena of thinking, environmental pollution, degradation, biodiversity, and sustainability are some of the key issues. It is, therefore,

imperative to follow ethical norms in animal biotechnology.²³

Climate Change and Its Impact on Animals and Humans

- K. K. Verma, Ph.D.

Retd. Professor of Zoology. HIG 1/327, Housing Board Colony, Borsi, DURG (CG) 491001, India
Email: kkverma.sheel@gmail.com

Climate change, mainly global warming, is not a myth (Verma, 2008), though some have taken it so. In the earth's history climate changes have taken place several times, but the present change is being catalyzed by human activities; hence the need to ponder on how the process of increasing warmth may be retarded, so that organisms have more time to get adapted to the change, and there would not be frequent extinctions and much loss of biodiversity. Global warming is affecting animal life in different ways, as may be seen in a few examples, cited in the following sections of this review.

The freshwater seals

Lake Baikal in Siberia is the largest and deepest freshwater lake in the world. It is the home of a seal, which is the only freshwater seal known. The number of this seal has been declining. The reason for this is that the female of the species raises her young ones on floating ice sheets in the lake, where they are well protected from terrestrial predators. With growing warmth the ice sheets are melting away, and the female is forced to bring up her pups on shores, where the young ones often fall pray to predators; hence the seal population is on decline (Verma, 2008).

The Antarctic Penguins

Dr. Heather Lynch of the Department of Ecology and Evolution at the Stony Brook University, has extensively studied the breeding habits of three species of Antarctic penguins, Adelie, Chinstrap, and Gentoo, using data collected through field observations and the satellite imagery technique. It has been noted that Adelie and Chinstrap migrate to the Antarctic Peninsula for breeding, but Gentoo use for breeding the main land of the Antarctica, where they live year-round (Stony Brook University Release of March 21, 2012). The Antarctica is the world's most rapidly warming region. This has raised the pace of the penguins' breeding cycle. The gentoo need less ice cover for their breeding. As a result of the warming such preferred areas for gentoo's breeding have been increasing. This factor plus the increased pace of the breeding cycle are favouring rapid growth of the gentoo population. Adelie and chinstrap need the Antarctic krill for food. (Krill are small shrimp like

²² EGE Report, 2008. *Ethics of Modern Developments in Agriculture Technologies*, Opinion: 23 & 24, the European Group on Ethics in Science and New Technologies to the European Commission, p.22.

²³ This article is the part of my Masters dissertation. I would like to thank Prof. Anders Nordgren, Linkoping University, Centre for Applied Ethics, Sweden, for his valuable comments which have enabled me to make this paper much clearer.

planktonic crustaceans in the Antarctic Sea.) The Krill need sea ice for their lifecycle. As the ice masses, floating on the Antarctic Sea, are melting away due to increasing warmth, krill supply to the Adelie and Chinstrap is declining. Thus in the warming up Antarctica gentoos are multiplying fast, while Adelie and Chinstrap are declining in number.

A northern navigational passage opens up between the Pacific and the Atlantic Oceans.

With the Arctic Sea icebergs melting, a much shorter ice-free northern navigational passage is opening up between the Pacific and the Atlantic Oceans. Hiede-Jergensen et al. (2011) have tagged some bowhead whales (*Balaena mysticetus*). Transmitter messages from the tags conveyed that in August 2010 two bowhead whales from Greenland and Alaska entered the northern passage from opposite directions, and spent nearly ten days together in the north of Canada. Thus with the northern passage, nearly free from ice, intermingling of the geographic populations of the whales in the two oceans is taking place. These observations suggest that the organisms from the two oceans will soon be interchanging.

Changing ecology, with climate change, affects plant and animal communities.

How with changing ecology plant and animal communities change is well illustrated by the study of the palaeoecologist Catherine Badgley and her coworkers of the University of Michigan (Anonymous a, 2008) on the Siwalik sedimentary deposits in the northern Pakistan. It has been inferred from this study that about 8 million years ago the climate of the Siwalik area became colder and drier. As a result the tropical forests in that area became replaced by savannah vegetation. With this the mammals, which fed on fruit and broad leaves, became replaced by grass feeding species. Some of the earlier forms could adapt to the new diet and survived, and the forms, getting extinct with this change, were replaced by immigrants, already well adapted to grass feeding. Among the fossils from the Siwalik are included two species of giraffes, rhinos, elephant relatives, several rodents, bush pigs, horses, antelopes, and apes.

Common responses of animals to climate change

Among birds the egg laying cycle may become faster. Mammals may end their hibernation earlier, or may not go into hibernation. Insect diapause may be similarly affected. As has been pointed out in the preceding section, distributional ranges of species may change. Many species may move northward or to higher altitudes in response to warming. Bird migrations may become shorter in range, or, if the climate is suitable in the inhabited area all the year round, migrations may be given up (Anonymous, 2010b).

Extinction and extirpation

Extirpation is extinction on a local scale. Animals respond to climate change by migration to a more favourable zone or by adaptation to the change. If either response fails, extinction of the species occurs (Anonymous, 2012c). Human induced climate changes are often so fast that it does not leave enough time for a species to get adequately adapted; hence the species go

extinct (Anonymous, 2009d). If a species, on facing a climate change, takes to migration to a new habitat with a more suitable climatic condition, it has to compete with a species already living in that habitat. In that competition the immigrant species or the species living in that habitat may prove to be the losing side in the competition, and may be driven to extinction. An example of this situation has been described by Meier (2010); that of Arctic Fox, the existence of which is threatened. Red Foxes are moving northward and to higher altitudes due to warming, and a conflict between the migrants and the smaller and gentler Arctic Fox is ensuing, and the latter may prove to be the losing competitor in this conflict.

It is estimated that, if the atmospheric temperature rises by 1.5° to 2.5° C, 20 to 30% plant and animal species go extinct (BBC publication, 2009). Anonymous (2012c), citing the views of Stuart L. Pimm, points out that human activities have raised extinction rates to one hundred times the natural, background rates. If emission of green house gases is not severely reduced, a quarter of land animals, birds, and plants will go extinct (Anonymous, 2010b).

Global warming and the carbon absorbing capacity of plants.

Satellite data have led to the inference that between 1982 and 1999 the amount of carbon absorbed by terrestrial vegetation increased by 6% each year (Perkins, 2010). But, as per Zhao and Running (2010), carbon pulled out from the atmosphere by plants dropped by 1% during the first decade of this century. This fall in the rate of carbon-absorption by plants has been ascribed to increasing warmth, boosting evaporation rate, which has led to water stress in plants, thereby reducing the carbon storage capacity of the plants. Increasing warmth and reducing c-absorption and storage in plants constitute a vicious chain, which should be curbed in the interest of life on our planet.

Climate change and Humans

As has been pointed out above, one way to face climate change is to get adapted to the changed climatic conditions. Humans develop the adaptation more readily than other species (BBC publication, 2009; Walsh, 2008). This is obviously due to the help from human technology. If it is so, humans, who are the most dominant species on the earth, will increase in dominance. Is it a desirable change? It is well realized that the present global warming is mostly due to human activities, which may be accentuated with his increasing dominance.

Though the human technology is helping *Homo sapiens* in readily adapting to climate change, he will not entirely escape suffering from this change. He will have to face new pathogens and allergens. With increasing warming, the atmosphere is sucking moisture from soil at an increased pace, and this is resulting in reduced crop production and paucity of safe drinking water (Anonymous, 2010e).

The modern human species was given the name *Homo sapiens* by Carl Linnaeus, the father of Taxonomy, in 1758. This Latinized binomial name means "Man the wise". It is being questioned whether Man has been really wise, having considerably reduced the life sustaining capacity of the earth (Cribb, 2011). May we not give him another name, say *Homo destructor*? But then the Rule

of Priority in the International Code of Zoological Nomenclature says that the earlier suggested name gets priority over later suggestions, and has to be retained. Hence the name *Homo sapiens* should be retained. Instead of violating a code or a rule laid down by us, we should strive hard to justify the name *Homo sapiens*.

What we may do to curb climate change?

An active search for alternative sources of energy is needed, so as to minimize our dependence on fossil fuels for energy generation. Nuclear power generation could be an important alternative. Besides there is need to design long duration energy storage cells, so that the electrical energy, generated from solar radiation, and from wind and surf power, may be stored for use, when and where required.

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Biodiesel Production from *Jatropha curcas* in Asia-Pacific: The Gap between Hype and Reality

- Abhik Gupta, Ph.D.

Dept. of Ecology & Environmental Science, Assam University, Silchar, India

Email: abhik.eco@gmail.com

Abstract

The *Jatropha* euphoria that was generated and nurtured in India and several other countries of the Asia-Pacific centers around the hypothesis that this versatile plant can produce oil-rich seeds with very little inputs in terms of fertilizers, water and labor on marginal land and wasteland not used for cultivation. In reality, however, *Jatropha* has been shown to have a high water footprint and needs substantial nutrient and labor inputs for economically viable biodiesel production. These constraints were primarily responsible for many Indian farmers giving up *Jatropha* cultivation on their lands. Besides, mass cultivation of *Jatropha* in biodiversity-rich areas is also fraught with the risk posed by the invasive potential of *Jatropha*. Another aspect that cannot be ignored is the toxic nature of *Jatropha* fruits and seeds. The continued interest of MNCs in *Jatropha* vis-à-vis the options for small and marginal farmers are also discussed.

Introduction

Biofuels derived from various biological sources can be used for transportation and heating purposes. Two major types of biofuels are bioethanol and biodiesel. The former is produced from crops like maize, sugarcane, wheat, sorghum, sugar beet, potato, and the latter from oilseeds like rapeseed, soybean, palm and *Jatropha curcas*, among others. Cellulosic materials like grasses and tree coppices can also be now used to produce bioethanol. Biofuels have evinced worldwide interest during the last decade owing to several reasons. These include energy security in view of the volatility of crude oil prices; socio-economic development of poor oil importing countries that have to spend a large share of their revenue for buying oil; greenhouse gas (GHG) emission reduction; and rural development and income generation (Dufey, 2007; de Fraiture *et al.*, 2008).

The *Jatropha* Euphoria

Among the biodiesel-yielding plants, *Jatropha curcas* L. (common name: physic nut or *Jatropha*) has attracted a lot of attention in recent years because of the positive energy balance of its oil and its ability to grow in an annual rainfall regime ranging from c 250-3000 mm. Among the other positive features are its role in preventing and controlling soil erosion; and its unpalatability to grazers and less vulnerability to pests and diseases. The multi-functionality of the plant is further illustrated by the fact that the press cake can be used as fertilizer or after detoxification serve as animal feed; the organic wastes can be used to produce biogas; the bark produces tannins and dyes; and the seed husk serves as fuel and

mulch. Thus it is projected as a plant that can achieve the multiple target of providing a renewable energy supply, tackle the challenge of GHG emission reduction, and generate rural livelihood opportunities (Achten *et al.*, 2008; Becker and Makkar, 2008). *Jatropha* oil also finds application in soaps, illuminants and paints. Leaves, roots and latex have medicinal properties and used in traditional medicine.

Endowed with so many interesting attributes, *Jatropha curcas* soon became the centre of a global hype that took the growing field of bioenergy development in a big way. Climate change researchers saw in it an opportunity to develop a powerful clean development mechanism (CDM) for reducing GHG emissions while maintaining the energy production for heating and transportation. Developing countries saw in it an opportunity to relieve the burden of oil imports on their economy; land managers welcomed the additional benefit of reclaiming wastelands in arid areas and arresting soil erosion; economists and politicians hailed it for its potential to generate livelihood opportunities (also rural vote bank for the latter!).

Jatropha curcas, a native of South and Central America, is now distributed in almost all tropical regions. It was first described and named in 1753 by Linnaeus. It belongs to the family Euphorbiaceae, and has a toxic and a non-toxic variety, the latter probably confined to Mexico. Because of the properties outlined earlier, *J. curcas* is considered by many to be superior to other biodiesel-yielding plants. Large areas of degraded crop lands available globally - countries like China and India each having more than 150 m ha of such land - are amenable to *Jatropha* plantations (Becker and Makkar, 2008). The enthusiasm around *Jatropha* can be gauged from the fact that in 2008, the total area planted under this species was some 721,000 ha that was projected to increase to 22 m ha by 2014 with an annual turnover of over US \$ 1 billion. Well-known companies entered the *jatropha* trade, prominent among these being D1 Oils of London, that had struck a USD 160 million deal with British Petroleum in 2007 (Sanderson, 2009).

The Hype and the Reality

Even in the midst of such heightened enthusiasm about *J. curcas*, Achten *et al.* (2007) pointed out that *jatropha* was still a wild plant that showed high variability in growth and seed yield. Though life cycle analysis (LCA) studies on biodiesel production from *J. curcas* showed a positive energy balance when the plant was grown using low input of fertilizer and irrigation, the balance became less positive under intensive cultivation using high fertilizer and irrigation inputs. The first question that therefore arises is how much inputs in terms of water and agrochemicals may be considered optimal for economically viable production of biodiesel from *J. curcas*? It is obvious that these inputs will vary depending on a number of factors like soil fertility status and other quality criteria, rainfall, temperature and humidity, slope of the land, and the like. The question that follows is what percentage of the farmers of the developing countries would be able to afford this optimal input in order to make the cultivation of *J. curcas* a viable sole or at least supplementary livelihood option for the rural masses as was envisaged earlier? The other issue pertains to the water footprint (WF) of *J. curcas* (and other biodiesel and

bioethanol producing plants). The water footprint of a product is defined as the volume of freshwater used to produce it at the place where it was actually produced (Hoekstra and Chapagain, 2008: quoted in Gerbens-Leenes *et al.*, 2009). The WF of a product comprises the *Green* WF, which is the volume of rainwater evaporated during production; *Blue* WF that refers to surface and ground water evaporated during production; and *Gray* WF which is the volume of water that becomes polluted during production. It was shown that *J. curcas* had the highest WF among 13 bioethanol and biodiesel producing crops. The total WF of *jatropha* was 574 m³ per gigajoule (GJ) of biodiesel and it required 19924 litres of water to produce 1 litre of biodiesel. The advantage of *jatropha* lay in the fact that the 12.8 megajoule (MJ) of energy production per kg of its fresh weight was the highest among all the 13 plants considered in the study. However, maize, wheat, barley, rice and rye also had almost comparable energy production levels (10.0, 10.2, 10.2, 10.5 and 10.5 MJ, respectively), but with a much lower WF (110, 211, 159, 191 and 171, respectively). Besides these crops, sugar beet, potato, sugar cane and Cassava had low WFs (59, 103, 108, and 125, respectively), although they produced only 2.6, 3.1, 2.3 and 5.2 MJ of energy per kg of fresh weight, respectively. It can also be noted that the blue WF of *jatropha* was also substantial (339) indicating that it needed high irrigation inputs (Gerbens-Leenes *et al.*, 2009). This was also shown by several other studies (Achten *et al.*, 2007, 2008; Ariza-Montobbio and Lele, 2010). Some ethical questions emerge at this juncture. Firstly, the WF data show that food crops like maize, wheat, barley, rice and rye are nearly as efficient as *jatropha* in energy production, but consume much less water. However, the question is whether we should utilize our food crops for production of bioenergy. Biofuels have been reported to have hiked world food prices by as much as 75 per cent²⁴. A World Bank report has also identified increased biofuel production as one of the causes of an 82 % rise in food prices between March 2006 and March 2008.²⁵ Eide (2009) has observed that "the liquid biofuel production has indeed contributed and is in the near future likely to continue to weaken the access to adequate food or to the resources by which vulnerable people can feed themselves.". The pathways to this weakening are threefold: first, by contributing significantly to the increasing food prices along with several other factors; second, by appropriating land for energy plantations, which in turn causes evictions and marginalization of vulnerable groups. Further, according to him, women, indigenous people and other such groups are also going to be severely affected due to an extensive spread of biofuel production. Third, biofuel production is also likely to adversely affect biodiversity and compete for the already scarce water resources.

A question arises as to the moral-ethical sanction for using our already scarce freshwater resources for energy production, especially when water scarcity is leading to

²⁴ Chakraborty, A. guardian.co.uk. 3rd July, 2008 [<http://www.guardian.co.uk/environment/2008/jul/03/biofuels.renewableenergy>]

²⁵ <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/LACEXT/0,,contentMDK:21781698~pagePK:146736~piPK:146830~theSitePK:258554,00.html>

small farmers giving up cultivation, especially of food crops, in large parts of the world, thereby compromising local, subsistence level food security. *Jatropha* has attracted worldwide attention because it is not subject to the greatest controversy surrounding biofuels, which is the exploitation of food plants as well as fertile agricultural land for energy production when millions remain hungry. As it is generally believed that *jatropha*, an inedible plant, can be grown with very little inputs in terms of fertilizers, water and labour on marginal land and wasteland not used for cultivation, it offered a wonderful opportunity for utilizing these land resources for green energy production without coming into conflict with food production. However, such contentions are removed from reality as it has been shown that *jatropha* cultivation needs a number of interventions for production of an economically viable quantity of oil-rich seeds. Before sowing of seeds or planting of cuttings, the land is to be cleared including cutting of shrubs and bushes. The land should ideally be ploughed and planting pits containing organic compost and/or synthetic fertilizer may be dug. Irrigation may be required, especially during the first 2-3 months of planting. Regular weeding, pruning and canopy management are required to induce lateral growth and early seed yield. The plants may also require heavy pruning every 10 years to induce new growth and stabilize seed yield. Further, as the fruits do not mature all at a time, manual harvesting of fruits at regular intervals is fairly labour-intensive. The dry seed yield ranged from <1000 – 2000 kg/ha/yr at < 1000 mm rainfall, and up to 4000 – 5000 kg/ha/yr at 1200 mm or more.

Thus *jatropha* had the potential to reclaim wasteland, although its ability to produce economically viable quantity of energy in barren, arid or semiarid lands remained doubtful (Achten *et al.*, 2007). Contrary to the claim that the toxicity and insecticidal properties of *J. curcas* prevented pest infestations, a number of insect pests, especially the heteropteran bugs posed serious problem to *jatropha* monocultures (Shanker and Dhyani, 2006). An FAO study (Brittaine and Lutaladio, 2010) has listed several “strengths” of *jatropha* such as its ability to grow on degraded soils and arrest land degradation; its relatively fast growth; its unpalatability to grazing livestock; the high suitability of its oil to be processed into biodiesel; alternative markets for its oil other than biodiesel; long storability of its seeds and others. But it has also mentioned its weaknesses the most important of which is the fact that *jatropha* can survive in poor growing conditions, but cannot produce enough oil without water and nutrients. The yield expectations touted in the press and certain publications are overestimates, and the 3-5 year time to reach economic maturity is long for most farmers, unless supported by the government.

Indian Case Study

Biofuel development was taken up as a highly prioritized objective in India because of the tremendous rise in the demands of the transportation sector and in view of the extreme dependence of the nation on crude oil import. This sense of urgency is evident in the 2003 Report of the Committee on Development of Bio-Fuel, Planning Commission, India. In his message at the beginning of the report, the then Deputy Prime Minister, L.K. Advani wrote that since high speed diesel (HSD) is

the main transport fuel, introduction of biodiesel as a petroleum diesel alternative or for blending with petroleum diesel could have several advantages such as emission reduction, energy security to remote and rural areas, employment generation, supply of rich biomass and nutrients to the soil, and control of widespread land degradation prevalent in the country. K.C. Pant, Deputy Chairman, Planning Commission, India, noted in his foreword that “India enjoys some special advantages in taking up plantation of tree-borne oil seeds for production of bio diesel as we have vast under-utilized or unutilized land, either fallow, barren, degraded or understocked, as in forests which are in drought-prone areas.” The advantages of *jatropha* over other tree-borne oil seeds were also reflected in his comment “... it has been possible to identify *Jatropha curcas* as the most suitable Tree Borne Oilseed (TBO) for production of biodiesel in view of its ability to thrive under a variety of agro-climatic conditions, low gestation period and higher seed yield... The capacity of *Jatropha curcas* to rehabilitate degraded or dry lands, from which the poor mostly derive their sustenance, by improving their water retention capacity, makes it an instrument for up-gradation of land resources and especially for helping the poor.”

The Report itself reasons that since the demand for edible oil is higher than production, none of this can be diverted for biodiesel production. *J. curcas* has been found to be the most suitable candidate for biodiesel as “It will use lands which are largely unproductive for the time being and are located in poverty stricken areas and in degraded forests. It will also be planted on farmers’ field boundaries and fallow lands. They will also be planted in public lands such as along the railways, roads and irrigation canals.” The report also set a target for biodiesel production. The ultimate objective was to achieve 20 % biodiesel blending of the total high speed diesel (HSD) demand of the country by 2011-12 beginning with 5% blending in 2006-07. This called for *jatropha* plantations on 2.19 million ha (Mha) of land to achieve the initial 5% target of 2006-07, and then gradually bring more land under *jatropha* to reach 11.19 Mha, which will be able to meet the 20 % blending level in 2011-12. Allocation of land for this massive exercise was to be undertaken in the following manner: i) of the 14 Mha degraded forest land under Joint Forest Management, 3 Mha (“notional”) was to be brought under *jatropha*; ii) of the total agricultural land of 142 Mha, assuming that farmers would like to erect protective *jatropha* hedges around their land, another 3 Mha could be obtained; iii) 2 Mha could be adopted by farmers for agro-forestry. Large areas of land are with absentee landlords, who are expected to go for *jatropha* as it “does not require looking after and gives a net income of 15000 INR per ha”; iv) 10 % of the 24 Mha cultivable waste lands, if brought under *jatropha*, could add 2.4 Mha; 2 Mha could come from wastelands under the Integrated Watershed Development Programme; 1 Mha was to be appropriated from the tracts of land along railway tracks, roads and canals; and another 4 Mha from various other sources could also be brought under *J. curcas* plantations²⁶. The total area of land to be brought under

²⁶Report of the Committee on Development of Biofuel, Planning Commission, Government of India, New Delhi – 110001: http://planningcommission.nic.in/reports/genrep/cmtt_bio.pdf

jatropha was around 17.4 Mha that was expected to yield oil which after transesterification and other processing could produce enough biodiesel to achieve 20 % blending of all petro-diesel by 2011-12, at the end of the XIth Five-Year Plan period.

Besides the government initiatives, private actors also entered the jatropha market. D1 Oils of London, UK, which is a global producer of biodiesel, formed a joint venture company with Williamson Magor & Co. Limited, one of the largest tea plantation groups in India, to develop *Jatropha* plantations in North East India. However, as reported in an "Operational Update" dated March 2, 2011, the company could not extract oil in the North East in the 2010 season due to unusually heavy rains²⁷.

Farmers' Experiences

In a conference on biodiesel with focus on jatropha organized by the Rashtrapati Bhawan (President's House), New Delhi, in 2006, farmers and entrepreneurs from different parts of India shared their experiences. Harlalka (2006) while recounting farmers' experience in Maharashtra was of the opinion that cultivation of jatropha singly was not cost-effective. The cost of drip irrigation was prohibitive as well. The support price of 25 INR per litre was much less than the production costs. Ranga Rao (2006) expressed concern at farmers abandoning traditional crops for planting jatropha. Often despite luxuriant vegetative growth on fertile soils, the plants failed to have sufficient fruiting and seed yield necessary for commercial feasibility. Furthermore, the plant was vulnerable to pests and diseases, dispelling one of the myths that jatropha was singularly resistant to pests and diseases. There was a wide gap between the countrywide hype generated and the actual field realities. Sharma (2006) while vouching for the various advantages of jatropha, also pointed out the water requirements of the plant. Without watering in the dry season, growth slowed down, plants shed their leaves and did not flower even at the end of the second year of planting. Inter-cropping with seasonal crops and irrigating the plots together could solve this problem. Gupta (2006) pleaded for a central body for certifying the quality of seeds. All the speakers at the conference emphasized the need for facilitating finance in the form of bank loans, microcredits, etc. and better marketing opportunities. Dange *et al.* (2006) spoke about the lack of authentic information on jatropha farming and the difficulty of removing from the field due to its ability of vegetative propagation. Nevertheless, they reaffirmed that jatropha also presented several points in its favour and offered a number of opportunities. Jatropha cultivation was also taken up in a big way in Udaipur district of Rajasthan. A study conducted among the farmers (Meena and Sharma, 2006) revealed that about 22.5 % of them faced high constraint in jatropha farming with another 67 % facing moderate constraint. Only 10.5 % of the farmers faced no problem in farming jatropha on their land. Although the average annual rainfall in Udaipur was c 650 mm, the most formidable problem faced was the lack of irrigation facilities, because of which the area was not suitable for growing jatropha in summer.

The findings of Ariza-Montobbio and Lele (2010) also disprove the overtly simplistic assumption that *J. curcas* can have viable seed/oil yield without irrigation. Even with irrigation, the yields were much lower than those in the experimental plots. Consequently, their study reported that 30% of the sample farmers had removed their jatropha crop because of the negative economic return. Yet another study in South India found that 90 (85 %) of the 106 farmers who had taken up jatropha cultivation in their land had withdrawn after a period of 1-2 years; of the remaining 16, only 9 continued with their cultivation. The remaining 7 did not maintain their plantations but also did not remove the planted jatropha because of the cost involved or because they had no alternative use of the land. Again, water scarcity and climate were the most common drivers behind discontinuation of jatropha by the 90 farmers (Axelsson and Franzén, 2010). Thus these field level experiences also shatter the myth of the ability of jatropha to grow and produce sufficient oil-bearing seeds without water, fertilizer, maintenance, etc. and being immune to pests and diseases. Therefore, the ethical propriety of making a nationwide campaign based on scanty and unreliable data, especially when the poor and marginal farmers were putting at stake their meager resources, remains questionable.

J. curcas and Biodiversity

The issue of jatropha vis-à-vis biodiversity is more complex, and needs to be carefully examined in the context of jatropha plantations already established or proposed to be established on degraded forest land. For example, the 2003 Report of the Committee on Development of Bio-Fuel, Planning Commission, India, recommends bringing 3 Mha of understocked forest land under jatropha. This land is to be obtained from the 14 Mha degraded forest land in the country under Joint Forest Management. South and South East Asian countries like India, Cambodia, Malaysia and Indonesia that have gone for large scale jatropha plantations share between them the rich and largely endemic and unique biodiversity contained in the four biodiversity hotspots (BHP), viz., Western Ghats and Sri Lanka, Himalayas, Indo-Burma and Sundaland. The Philippines, another BHP, also has plans to develop large scale jatropha plantations. Similarly, in Africa, jatropha plantations have come up in Madagascar (Madagascar and Indian Ocean Islands BHP), South Africa (Cape Floristic Region BHP), and Mozambique (Coastal Forests of Eastern Africa BHP). Besides these, jatropha projects are also slated to be established in the Yunnan province of China (Mountains of Southwest China BHP), Mexico and Brazil (Mesoamerica and Cerrado BHPs).²⁸ Jatropha plantations have also been established in three biodiversity-rich districts in Zambia having annual rainfall between 800-2000 mm. However, an IUCN, Nairobi, publication also advocates precautionary measures in view of the potential invasive nature of jatropha²⁹. It may

²⁸ http://www.emerging-markets.com/biodiesel/pdf/BiofuelsInternational_FeedstockTrends_Jatropha_September07_WillThurmond.pdf

²⁹ IUCN, Nairobi, 2009. Growing of *Jatropha curcas* L. & the potential of it becoming invasive in Zambia: http://cmsdata.iucn.org/downloads/09_jatropha_curcas_and_invasion_in_zambia_april_2009_b_nkandu.pdf

²⁷ <http://www.d1plc.com/2011/03/02/operational-update/>

be unwise to plant jatropha on extensive areas in biodiversity-rich zones before ascertaining its invasive properties. The 'Pacific Island Ecosystems at Risk' (PIER) assessment of jatropha identifies it as "high risk" in terms of invasive potential³⁰. Brittain and Litaladio (2010) have also listed it as an invasive species in certain environments.

This paper, therefore, suggests that even degraded forests that have a capacity to regenerate if left to them or through aided natural regeneration should not be used for jatropha cultivation, especially in biodiversity hotspots. Introduction of alien species is always fraught with risk. In Manipur state in India, *Bracharia mutica* (para grass), which was introduced in the Loktak Lake - a Ramsar site - to improve fodder potential, now poses serious threat to the indigenous plant communities and the lake ecosystem as a whole. *Mimosa himalayana* introduced in some tea gardens of North East India, is endangering the natural grasslands of the Kaziranga National Park and several other protected areas. Fletcher *et al.* (2011) have conducted a quantitative meta-analysis of the biodiversity values of four common biofuel crops in USA, viz., corn, switchgrass, pine and poplar. The projected loss of biodiversity was found to be the highest in corn. They also pointed out that remarkably little is known about the biodiversity associated with energy crops like *Miscanthus* and *Jatropha*. Viewed in this perspective, large scale planting of jatropha in Assam, Manipur and other North East Indian states by D1 Oils and others without conducting prior studies to assess its invasive properties and its effects on biodiversity, is contrary to ecological as well as ethical norms.

Jatropha Toxicity

The other issue that warrants attention is that of toxicity. *J. curcas* seeds are highly toxic, and being attractive, children are common victims of poisoning in areas where this plant is common. *J. curcas* seeds produced restlessness, severe vomiting and dehydration in two children after accidental ingestion. The seed was also found to cause gastrointestinal infarction in mice, resulting in anal bleeding and death (Abdu-Aguye *et al.*, 1986). An incidence of mass poisoning of 20 children was reported from Karnataka (Kulkarni *et al.*, 2005). Bird and animal poisonings from extensive jatropha plantations is also a matter of concern. Jatropha seeds were found to be toxic to chicks (el Badwi and Adam, 1992) and to sheep and goats (Adam and Magjoub, 1975; Ahmed and Adam, 1979). The toxicity of jatropha has been identified as a health risk to workers, children and livestock (Brittain and Litaladio, 2010). Horiuchi *et al.* (1987) reported the presence of malignant skin tumour promoters in the seed oil. Thus with large scale production of jatropha biodiesel from extensive jatropha plantations, risk of toxicity and other health hazards to the children of these areas as well as to the workers handling jatropha seeds and seed oil, cannot be ruled out.

Conclusions

This paper is not meant to discourage jatropha or the production of biodiesel from this plant. There is nothing wrong with jatropha. In fact, it is a highly versatile plant in

terms of the wide range of products and services it can deliver even under unfavourable ecological situations. Achten *et al.* (2010) have proposed an alternative model where the multiple benefits from jatropha are capitalized in small-scale community-based initiatives for rural development. But it is to be realized that perhaps no plant or any other organism that is the product of a natural, organic evolution could live up to the unrealistic and unjustified demands to become the proverbial "wonder weed" or "wonder plant" to solve all problems with one stroke. Such a demand on jatropha or any other organism also flouts ethical norms, especially from an ecocentric point of view.

Like many other programmes not only in India, but in several other Asia-Pacific and African countries, the jatropha initiative was either based on insufficient data, or it is more likely that the available data were not properly analyzed and interpreted. There was no trade-off analysis and only the pros were considered to float a model where data were made to fit into a preconceived model instead of being the other way round. It is needless to say that this also flouted the principles of informed consent and informed choice when offered to the farmers. Parawira (2010) has also emphasized the need to conduct thorough research before embarking upon large scale introduction of jatropha. As seen earlier, the hasty promotion of jatropha has resulted in farmers, especially small and marginal ones, withdrawing from it in most parts of India. But at the same time, the corporate world has renewed its interest in jatropha with D1 Williamson Magor bringing more areas under jatropha in Assam and the other North East Indian states, with several other corporate players also expressing interest in jatropha projects in India. This has been termed as the 2010 revival of jatropha characterized by renewed interest in jatropha in India and other Asian countries including China³¹. It may be premature to make any definite projections at this point of time, but the growing interest of large scale corporate enterprises in jatropha accompanied by a waning interest among small farmers could signal that the future path of jatropha plantations will follow that of tea, coffee and rubber with small players struggling on the edges to eventually perish or remain at the 'mercy' of the big actors.

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³⁰ http://www.hear.org/Pier/species/jatropha_curcas.htm

³¹ <http://biofuelsdigest.com/bdigest/2010/05/28/jatrophas-2010-revival-continues-digest-round-up/>

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Dams and their ecological effects

- A.J. Thattheyus, *Delphin Prema Dhanaseeli and *P. Vanitha PG & Research Department of Zoology, The American College, Madurai-625 002, Tamil Nadu, India.
Email: jthattheyus@yahoo.co.in
*PG & Research Department of History, Jayaraj Annapackiam College for Women, Periyakulam-625 601, Tamil Nadu, India.

Introduction

People have been moving around river systems from time immemorial. Great civilizations like Sumaria, Egypt and China were based on mega irrigation systems. In fact organizing people towards such projects served as a catalyst for the origin of civilization. In *Genesis* 2:10 of the Holy Bible, it is also mentioned; "Now a river went out of Eden to water the garden, and from there it parted and became four riverheads."

Since the middle ages, falling water has been used as a source of power. The efficiency of hydropower dams has increased with the invention of water turbines in the 19th century. Even though hydropower now occupies only one quarter of total electricity generation, many countries generate most of their electricity through hydropower. Norway depends on hydropower for 99 percent of its electricity. Countries like Brazil, Switzerland and New Zealand generate about three-quarters of their electricity through hydropower, Canada being the world's largest producer, generates more than 60, 000 MW through falling water.

The dams bring pride and prestige to the countries that build them but they do have certain unwanted social and environmental effects. According to old English common law, the capture of water in itself is a hazardous activity and whoever captures the water is held responsible for any damage caused by the capture or release of the stored water. Hence the proponent is responsible for the safety of the dam. Electricity is a key parameter for improving the lives of millions of poor people throughout the developing countries. In such countries, rapid industrialization, urbanization and population explosion will ensure increased demand for electricity for decades to come even with energy efficiency measures. Many

countries of the world rely on hydropower for a substantial portion of their electricity needs and it is considered as a promising and renewable source of electricity.

Development and destruction are the two sides of the same coin and economic, social and environmental changes are inherent to development. The strategy to have development with little adverse impact on society and environment has led to sustainable development. Recently major international initiatives like world Summit on Sustainable Development at Johannesburg in 2002, World Water Forum at Kyoto in 2003, World Commission on Dams (1997 – 2002) and the ongoing Dams and Development Project of the UNEP along with the World Bank have supported hydropower development but with due social and environmental concerns.

Dams are of several types. Check dams are meant for preventing flooding of small areas while Diversion dams divert river water to irrigation. Large dams may be constructed for flood control or hydropower generation or for both. Flood control dams may be earth dams built with clay, sand, gravel and rock or concrete dams. Hydroelectric dams are often built with concrete.

Large Dams

In dam building, USA occupies the first place followed by China and India. India before its independence in 1947 had about 300 large dams and it increased to 4000 by the year 2000. About 96 percent of them were constructed primarily for irrigation. Most of them are embankment dams which consist of a wall built across a river to impound water forming a reservoir in the upstream and a set of spillways and gates to bypass the wall to maintain water flow through a network of canals for irrigating downstream areas. The upstream region before the dam with the reservoir is the catchment area while the downstream regions fed by the water are termed as the command area.

Advantages

With dams and reservoirs, runoff can be trapped and transferred from water excess areas to water scarce places through canals, tunnels and underground pipes. Dams ensure a year round water supply and offer control over floods and reduce coal burning which is the major cause of green house effect, global warming, acid rain and respiratory diseases leading to deaths. They increase the economic activity in the catchment area through construction and economic activities around the dam like tourism and fishing.

Dams offer many benefits by storing water in times of surplus and dispensing it in times of scarcity. They do prevent or mitigate devastating floods and catastrophic droughts. They could adjust natural runoff to meet the pattern of demand for irrigation, power generation, industrial and domestic needs and navigation. Large dams are the cheap and renewable sources of electricity available with less adverse environmental impacts.

Disadvantages

Water transfer through dams affects natural balance of rivers, streams, estuaries and terrestrial ecosystems. Dams also become a hindrance to fishing enthusiasts, white water boaters and people who enjoy the aesthetic beauty of running water systems. These dam projects in

some countries consume public funds to increase the value of farmland held by rich landlords and encourage development of agriculture and urban growth in arid lands where other uses might be more appropriate.

The acidified water from reservoirs will damage the turbine blades impairing the generation of hydropower. Dams reduce water availability and destroy both natural and human values. They also exhibit inefficiency in water storage as they lose so much water through evaporation and seepage into porous rock beds that they waste more water than they make available. The salts left after evaporation increase the salinity of the river water and make it unfit for use. Hence for restoring the water quality, more money has to be spent towards the construction of desalination plants.

Dams built above geological fault line with the enormous weight of the water in the reservoir may trigger seismic activity which may cause the breach of the dam resulting in heavy floods. At present the largest hydroelectric dam of the world is the Itaipú dam on the Parana River between Brazil and Paraguay. It has been designed to produce 12,600 MW of power, which has flooded 1300 sq.km of tropical rainforest and displaced many thousands of native peoples and millions of other organisms. The problems associated with large dams include human displacement, ecosystem destruction and wildlife cover. Failure of dams can result in catastrophic floods and thousands of deaths. Large dams cause loss or negative impacts on ecology, biodiversity and habitats of the riverine ecosystems. Construction of dams and impoundment in the form of reservoirs leads to a heavy loss of cropland and forest. Increased salinity due to water logging reduces agricultural productivity near the reservoir.

Sedimentation

The rivers drain their load of suspended materials and silt behind the dams making them useless for either water storage or hydro power generation. Dams can withstand the force of water but they can't bear the additional force of wet sediments accumulating on the dam side. It can lead to the burst of dams destroying settlements downstream. These accumulating materials clog the reservoirs and also result in the loss of valuable nutrients. The Sanmenxia reservoir in China silted in four years while Layong Reservoir was filled with sediments even before it was finished. When the annual floods are prevented by the dams, the nutrient-rich silt cannot reach the nearby agricultural fields to make them fertile. Hence the farmers have to spend more money on the application of commercial fertilizers. The rich fishery resource supported by the nutrients brought by the rivers has been subjected to a decline in the marine environment and habitats like Mediterranean Sea even experience a loss of 97 percent in sardine fishing.

Sediment Removal

The river after the dam fakes up the sediments from the stream bed by erosion as the natural sediments are held up before the dam. The river downstream of the dam is not muddy but clear due to the absence of sediments and many of the animals cannot escape and are vulnerable to predation finally leading to their extinction.

River Starvation

Dams prevent the flow of debris including leaves, twigs, branches, trees and the organic remains of dead organisms in the river downstream. Debris not only provides food and nutrients but also hiding places for several animals and attachment for the growth of microbes and phytoplankton. As dams prevent the natural floods, debris will be scarce and there is a loss of habitats and nutrients for lotic organisms.

Temperature Alteration

Temperature is a critical factor for the survival, growth and reproduction of many organisms. Rivers without embankment are fairly homogenous in temperature while the reservoirs are thermally stratified. They are warm at the top epilimnion and cold at the bottom hypolimnion. As water is released from the bottom of the dam in the downstream river the temperature prevailing is colder than that of normal. As a result the physiological mechanisms and developmental processes like metamorphosis are either delayed or affected.

Displacement

In certain cases large dams will drown villages and towns along with historically important temples, rock carvings and archaeological sites and millions of people have to become oustees. Due to inundation, culturally significant regions of archaeological, historical, paleontological and religious importance may disappear. The Akosombo Dam constructed across the Volta River in Ghana displaced 78, 000 people from 700 towns. The Narmada valley project in India displaced about 1.5 million people and the China's Three Gorges Dam about displaced one million people. Many of them have to become oustees and occupy temporary shelters losing their livelihoods. The Brokopondo Dam in Suriname submerged about 160, 000 hectares of tropical rainforest known for its rich biodiversity and resulted in serious water quality and aquatic weed problems while generating a low hydropower of 30 megawatts.

The adverse social and environmental impacts of large hydroelectric dams are diverse. Some of them may occur during construction or during long-term existence and operation or during complementary civil works like access roads, power transmission lines and quarries and borrow pits. Dams and their infrastructure with power stations and irrigation canals contribute to large scale of displacements. This will increase their vulnerability to social disruption. Many of them will be indigenous people with traditional land-based models of production and livelihoods. According to World Bank, roughly about ten million people are displaced every year due to dam construction, urban development and transportation and infrastructure programs. The livelihoods and the socio-cultural milieu of, not only the displaced but also the people living in the vicinity and the downstream of the projects are affected.

Health effects

Growth of snail populations in the shallow irrigation canals which distribute the stored water from dams to agricultural fields results in the epidemic of Schistosomiasis which is caused by blood flukes (parasitic flatworms) spread by snails. Decomposing plants and trees in artificial impoundments deteriorate

water quality. The hydrogen sulfide emanated during decomposition would kill fish and drive out the nearby native people. Floating water hyacinths which are rare on running rivers have spread over reservoir surfaces behind the Tucurui Dam in the Amazon River in Brazil impeding navigation and fouling machinery. Application of herbicides to remove such aquatic weeds has resulted in the contamination of the water systems. Storage of water in the reservoir increases the incidence of Vector-borne diseases like malaria, filariasis, schistosomiasis and river blindness.

Biodiversity loss

The adverse environmental impacts due to large dams include irreversible biodiversity loss due to the submergence of critical natural habitats not occurring elsewhere and the prevention of fish passage facilities which impair species composition and fish migration.

Inundation of native forests threatens biodiversity and releases green house gases. In certain cases, when the reservoir undergoes thermal stratification, the deeper zone, hypolimnion becomes stagnant, anaerobic and unsuitable for supporting most aquatic life. Generally lowland rivers in tropical regions have a high diversity of aquatic life and significant seasonal fish migrations and these are blocked by most dams. The plant and animal communities' inhabiting a river and its margins are adapted to the peculiar pattern of flood and drought and slow and fast current which are unique to riverine ecology. But dams disrupt this delicate ecology and several impacts of dams on fisheries and aquatic ecology take place during the operation phase also. The impacts include effects on fish and fisheries and deterioration of fish diversity, fish stocks and fisheries production.

Affecting Natural Cycles

Dams alter the flooding patterns of the river for which the animal and plant communities are adapted. Many aquatic animals synchronize their reproductive cycles with annual floods. The nutrients brought by the floods nourish the inhabitants of the river. The juveniles of many animals escape from their predators in the shallow backwaters on shaded riversides and the vegetation provided by the floods. As dams prevent the floods, fish produce young ones in the wrong times of the year and they can't find their normal food supply and temperature preferred during those times. Riparian vegetation bordering the river is also replaced by other species. In the absence of dams, the river experiences small and sudden floods which bring or remove silt, sand, gravel, hydrophytes, leaves and debris. This creates unique and conducive habitats which can favour the inhabitation of several fish and invertebrates.

Fish Migration

Dam serves as an obstacle for fish migration and many fish have to move either upstream or downstream for completing their lifecycles. Many young ones are killed by their predators when they wander in the reservoir. Many of the dams are constructed without fish ladders and even if they are built, the young ones cannot climb. Some fishes after crossing the dam are killed by the fall or by the exposure to high levels of nitrogen at the base of the dam.

Greenhouse gases

Greenhouse gases like methane and carbon-dioxide are released into the atmosphere when forests are brought into submergence for dam construction. These gases are responsible for human-induced global climate change. The Balbina dam in Amazonian Brazil emits greenhouse gases in larger amounts as the reservoir floods extensive forest areas. Indian reservoirs generate about 45.8 million tonnes of methane and the emission from large dams amounts to 33.5 million tones. Emission of methane from the reservoirs of the whole world could be around 120 million tonnes per annum. Of the total emissions of methane due to anthropogenic activities, contribution from large dams alone could be about 24 percent. In addition, other greenhouse gases like carbon-di-oxide and nitrous oxide are also released from large dams. Thus the large dams contribute much to global warming.

Dam Failure

Failure of the dams depends on factors like seismicity of the region, spillway capacity, and quality of construction, disaster management, bombing by terrorists or enemy countries. The causes of the dam failure include liquefaction of the materials used in the dam and the foundation soil, wrong estimation of the peak ground acceleration, slope failures induced by ground motions, and sliding of the dam. All over the world, about ten percent of the dams failed and about two percent of them are reported to have collapsed. About 2000 dams have been identified by the US experts as unsafe. The reasons for the failure of dams include weak foundation materials, disruption of dam by major fault movement in the foundation, loss of freeboard due to differential tectonic movements, slope failures or soil compaction, piping failure through cracks induced by the ground motions and overtopping of dam due to seiche and slides in the reservoir.

Conclusion

Dams for the generation of hydropower can be constructed in sites where there is minimal loss of natural habitats and less number of people for resettlement. Dams constructed in inappropriate sites will be highly problematic even if all the mitigation measures are efficiently implemented. Dam sites have to minimize the length of river impounded by the reservoir. The length of the river left dry below the dam due to the diversion of water has to be minimized because of the loss of aquatic life, damage to riparian ecosystems and disruption of water supplies, agriculture and fishing. If the dam is constructed in the upstream, it is easy to maintain accessible habitat for migrating fish, the natural flooding regime for rivers and nutrient or sediment input necessary for the high biological productivity of estuaries.

Proper implementation of mitigation measures will help to reduce the negative environmental and related social impacts to lower levels. But in many situations mitigation measures are not often fully implemented, and are sometimes inherently inadequate. In certain cases, practically, due to limited budgets, tight construction schedules, conflicting priorities and weak implementing agencies, mitigation measures are often not implemented effectively. The alternative to large dams will be low-head hydropower technology with small headwater dams that

cause much less damage. High-efficiency turbines operating on run-of-the-river flow will not impede navigation and spawning migration of fishes.

Instead of building dams to prevent flood damages and to store water in reservoirs for future use, watershed management can be considered as an economic and eco-friendly alternative. The main cause of flooding is rapid forest clearing and agriculture on unstable headwater slopes. Proper land use patterns and soil conservation measures would help more in holding back runoff than that of a dam.

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The Ethical Issues of Biobanks in China

- Yanguang Wang, Ph.D.,

Professor, The Center for Applied Ethics, Chinese Academy of Social Sciences, Beijing, People's Republic of China

Email: ameliaw2002@hotmail.com; ameliawyg@sohu.com

Abstract

In 1998 China's Ministry of Science and Technology established two national human genome research centers. The two national centers, in Beijing and Shanghai, together with many other genetic facilities at the provincial level, have announced the establishment of several special disease-related databases. In particular, Chinese geneticists have constructed the database for genomic polymorphism of the 56 Chinese ethnic groups.

Biobanking practices can raise a number of ethical challenges. Those challenges concern the participating individuals' trust, confidentiality regarding their personal information and the question of who should benefit from commercial gains arising from genomic research, issues of privacy, informed consent, traceability and feedback of

participating research subjects and issues of international collaboration.

For example, in a workshop, a scientist of the Wenzhou Medical College described some of the many challenges his college faced when they started to set up a biobank. Some consent forms did not strictly follow international standards. The situation of national standards for China was unclear. There was no quality control for some sample collection and processing. There were no facilities with well-controlled environmental conditions to store samples permanently. They also sought to establish standards for operational procedures, including sample collection and preservation, as well as clinical information management.

This paper discusses the ethical issues of Chinese biobank from the Chinese point of view, while the biobank is still developing, rather doing so after it is developed.

Genetic factors contribute to the etiology of many conditions, including cancer, heart diseases, diabetes, asthma and Alzheimer's disease. In addition, certain people are more susceptible to infections than others. Environmental factors, such as smoking, also greatly affect human health. In essence, many diseases are the result of gene-environment interaction. The human genome project has successfully sequenced about 30,000 human genes. This new genetics provides an exceptional opportunity to move forward to understand the variability in human health. Consequently, we will be able to develop more meaningful and practical information.

A biobank, designed properly, will provide a powerful means of identifying the many causes of disease and how they interact with each other. Subsequent discoveries will provide better treatment of many diseases. A biobank will allow the risk of disease to be predicted for the individualized medicine. A biobank is a resource for many studies, both prospective and retrospective, to be conducted. In addition, samples can be tested repeatedly when and if technology advances. In the long run, biobank is a resource that will save a great deal of research money.

Biobanking practices can raise a number of ethical challenges. Those challenges concern the participating individuals' trust, confidentiality regarding their personal information and the question of who should benefit from commercial gains arising from genomic research, issues of privacy, informed consent, traceability and feedback of participating research subjects and issues of international collaboration. While biobanking is developing, we should discuss these issues of bioethics. This paper is an introduction to the ethical issues of biobank in China.³²

1. Biobanks in China

In 1998, to catch up with the latest developments of the international Human Genome Research Project, China's Ministry of Science and Technology established two national human genome research centers. They are located in Beijing and Shanghai. The two national centers, together with many other genetic facilities at the

provincial level, have announced the establishment of several special disease-related databases. In particular, Chinese geneticists have constructed the database for genomic polymorphism of the 56 Chinese ethnic groups.³³

Recently, established biobanks have reached unprecedented levels of scale, particularly the Taizhou Biobank Project in China. Studies conducted on the entire population of a country may soon be possible. The Jiangsu Taizhou of China Longitudinal Cohort Study began in 2007. It is a base-immortalized cell bank that was designed for and involved the collection of samples, medical history and lifestyle information from 100,000 donors in Taizhou, China. The goal of the baseline investigation was fourfold: to describe the mortality and morbidity characteristics of common chronic diseases; to determine environmental risk factors and life course causes of common chronic diseases; to determine genetic risk factors underlying common chronic diseases; and to determine the contribution by gene-environment interactions underlying common chronic diseases.

The Taizhou Biobank Project had trust-building measures built into the project. Fudan University made efforts to explain the purposes and process of the study to the subjects individually and at the community level. A bar-coded identification was given to each subject for informed consent, and privacy protection. The first page of the questionnaire, containing identification information, was removed. The identification information was entered separately from other information. All identification information was kept in a separate database, to be kept offline.

A four-step, trust-building strategy to mobilize research subjects was made. The first step was to use the mass media city-wide through television, radio, newspapers, etc. The second step was to reach the community, three days before starting the project, by putting posters on entrances of certain buildings, and staffing a booth to handle questions at the community center. The third step was to obtain informed-consent forms at the person-to-person level. The fourth step involved re-contacting subjects with follow-up questions, and establishing a "hot line" to respond to questions by telephone.³⁴

The methods of sampling, questionnaire design, training, physical examination, laboratory examinations, and data management have been centralized and standardized. The training of field staff involved in data collection, and office staff handling data entry, checking, and cleaning was implemented. The internal controls for the quality of measurement are based on collecting measures of selected factors.

The Kadoorie Study Cohort Profile on Chronic Disease began in 2004. Study sites include ten rural places and ten cities. The sample population is aged 35-74 years, both male and female, having a sample size of about 500,000, with 50,000 from each site. The baseline survey was finished in 2008, using a total of 515,000

³³ Xinqing Zhang, Ethical reflection on Creation of Human Genetic Database: Based on a National Survey on Chinese Genetic Scientists, *Eubios Journal of Asian and International Bioethics*/ 2007; 17: 2-4.

³⁴ Ayo Wahlberg and Ole Doering. 2009. *The Bionet 4th workshop report*. p5, p7. Available at: <http://www.bionet-china.org> [Accessed 20 Aug 2010].

³² Matti Hayry, Ruth Chadwick. 2007. *The Ethics and Governance of Human Genetic Databases*. New York: Cambridge University Press: 94.

persons. The information collected was on socioeconomic data, health behaviors, general health-related data, family history, sleeping patterns, mood and mental situation, reproductive history, follow-up for death cases and diseases. With the project, the scientists made efforts to explain the purposes and process of the study to the subjects individually and at the community level, by using such trust-building measures that were incorporated into the project.³⁵

In 2008, Wenzhou Medical College (WZMC) established a biobank for epidemiology research, and a biobank for forensic research and individual identification. The goals of the biobank include collecting and storing a total of 500,000 serum and DNA samples derived from human blood in all hospitals of WZMC in 10 years at the rate of 50,000 per year, and collecting and storing a total of 20,000 tumor samples, combined with paired tumor surrounding tissues and blood at the rate of 2,000 per year. Other goals are the integration of various tissue banks and clinics, with information of individual medical histories, lifestyles, occupations, and establishment of a disease-targeted biobank with the pathological information for the introduction of and practice on diseases of cohorts. Additional goals are the collection, banking, and distribution of human tissue and fluid specimens, establishment of protocol of human consent which follow international standards, establishment of standard operating procedures, including samples collection and preserving, clinical information management.³⁶

There are 56 ethnic groups in China, each of them having independence in their areas of habitation, and some of the more genetically isolated population. At the source of ethnic groups and genetic phenotypes, each of the ethnic groups has its unique characteristics. There are significant difference categories, enzyme systems, HLA antigen and incidences of some genetic diseases.

An institute of the Chinese Academy of Sciences made scientific efforts to establish immortalized cell lines from different ethnic groups in China from 1994 to 2009. To improve informed consent, the scientists used local national minority languages to communicate with potential research participants with the support of local minority doctors, village teachers, cadres and sometimes also local religious leaders. They explained the significance of the research, gave medical service to local people, including medical counseling. The scientists described what was needed to get the help of volunteers, explained the risks that volunteers may undergo, described the benefits which volunteers may obtain, and described how to protect individual privacy, security, named contact persons, and noted that the local individual's doctor is the best choice for care.

The informed-consent sheet invited individuals to participate in a research study that was being conducted by the Institute of Medical Biology, Chinese Academy of

Medical Sciences. It described the purpose of this study as trying to better understand genome diversity and its significance in diseases. It explained that participation in this study was completely voluntary, and that individuals may refuse to participate and/or withdraw their consent and discontinue participation at any time without any penalty.

The informed-consent sheet told people that no matter what they decided, it would not affect their medical treatment. If they agreed to participate in the study, they would be asked to donate a 10 ml blood sample. It stated that there were no known risks involved with this study. It informed participants that the collection of blood may cause a small amount of pain. The sheet said that participants would not benefit directly from participating in this study, but that their participation would benefit the general population by increasing knowledge related to genome diversity and its significance in diseases.³⁷

For their compensation, the informed-consent sheet stated that participants would be paid XX Yuan for delaying their work and an additional XX Yuan for donating 10 ml of blood. All information that was obtained in connection with this study and that could identify the participant will remain confidential and be used only for scientific purposes. Only grouped data will be used in analysis and no individuals will be able to be identified in the results. All biological samples will not be labeled with the participant's name.

The informed-consent sheet offered a contact for questions about the study. If the study staff could not answer the questions, interested persons may contact Mr . XXXX, the local doctor, at telephone number : 999999, or write to the following address : XXXXXX . Or, they may contact Dr. XXXX, the leader of the study at telephone 7777777.³⁸

2. The Ethical Issues of Biobanking in China

In the Wenzhou Medical College Biobank, scientists found that currently many biobanks operate without clear legal regulation. There are currently very few specific legal regulations pertaining to such collections. Bioethics committees usually were given key roles in oversight and regulation, but procedures and practices varied within and between cities. In a workshop, a scientist of the Wenzhou Medical College described some of the many challenges his college faced when they started to set up a biobank. Some consent forms did not strictly follow international standards. The situation of national standards for China was unclear. There was no quality control for some sample collection and processing. There were no facilities with well-controlled environmental conditions to store samples permanently. They also sought to establish standards for operational procedures, including sample collection and preservation, as well as clinical information management. This scientist

³⁵ Wu Fan. 2009. Kadoorie Study Cohort Profile: Chronic Disease in China. In *Ethical Governance of Biological and Biomedical Research: Chinese-European Co-operation 4th Workshop*. Shenzhen, China: CD

³⁶ Zhongsheng Sun. 2009. Establishment of Biobank at Wenzhou Medical College. In *Ethical Governance of Biological and Biomedical Research: Chinese-European Co-operation 4th Workshop*. Shenzhen, China: CD

³⁷ Ayo Wahlberg and Ole Doering. 2009. *The Bionet 4th workshop report*. p7-8. Available at: <http://www.bionet-china.org> [Accessed 20 Aug 2010].

³⁸ Jiayou Chu. 2009. "Informed consent" and Establishment of Chinese Different Ethnic Groups' Immortalized Cell Line Bank 1994-2009. In *Ethical Governance of Biological and Biomedical Research: Chinese-European Co-operation 4th Workshop*. Shenzhen, China: CD

expressed his hopes that collaboration with foreign partners would support his institute's efforts towards good governance, especially while domestic regulatory guidance remained weak.³⁹

Some more important ethical issues were identified: the public's trust and support for biobank research; what kinds of risks participants faced; and how feedback (benefits) to research participants should be conceptualized, communicated and organized. It was also debated whether it was realistic to expect that individualized feedback and benefit sharing was feasible, bearing in mind that larger and larger sample populations were required. A scientist pointed out that, from a Chinese point of view, 'benefit sharing' and 'informed consent' belong among the 'missing essentials' for a desirable regulatory and conceptual governance framework. He called for special provisions to target benefit sharing.⁴⁰

How can we do better in China? A professor shared his opinion that national governmental leadership and investment were needed, national policy, planning and guidelines, coordination and integrative action were needed, and technical advice and financial support, ethical governance, communication and sharing were required.⁴¹

In particular, the Pearl River Delta in China should be seen as an emerging hub in the area of biobanks and the related sciences. However, the region still faces considerable challenges. Even basic efforts to combine scientific and technological growth with ELSI-related capacity building were felt to be largely absent. There is no orchestrated development plan, no funding scheme, and no concept for how to establish good governance.⁴² A heated debate about what feedback (benefits) biobanks are obliged to give to individual research participants has occurred among Chinese.⁴³

More concerns are about confidentiality and privacy of data held on the Internet. The concerns have led to regulation and governance of biobanks. Other sources of concern include the conventional ones about informed consent, anonymity, or about the use of the material for purposes other than stated when it was collected. Another set of questions concerns the ownership of the genetic information and the results of analysis, and hence of any potential commercial benefits that might arise from the use of data in a biobank.

The concerns about commercial uses are particularly salient when material is collected in one population, but the benefits are thought to flow to other populations, or to private commercial companies. These issues become

more important with the emergence of international networks which involve the sharing of material and information from biobanks.

Currently many biobanks operate without clear legal regulation, and there are currently very few specific legal regulations pertaining to such collections. With so many biobanks emerging throughout China, it is important to clarify what governance procedures they are under, which is an arduous task given the developing situation of biobanks. In China, some biobanks are commercially owned, others are public. It is difficult for donors to know what biobanks were doing with their samples. Transparent governance procedures and structures may be a good way to provide clarity.⁴⁴

3. Suggestions on Ethical Governance of Biobanks in China

I recommend, on the basis of standard European data protection principles, a minimum set of safeguarding requirements to consider before allowing access of biobank information databases to international law enforcement agencies. This would ensure that there is a sufficient level of data protection for all authorities/agencies that would receive information. This would subject each request to adequate scrutiny as to merit and reasonableness and be on a transparent basis. There would also be agreement of the criteria for sharing data. For example, sharing data would only be for the investigation of serious crimes or in special circumstances. It would involve sharing only as much information as is necessary to meet the request and only to those authorities or agencies which have a "need to know."⁴⁵

We also recommend revisions to the "Interim Measures for the Administration of Human Genetic Resources." To prevent illegal access and misappropriation by commercial corporations from developed countries, China enacted the "Interim Measures for the Administration of Human Genetic Resources" ("Interim Measures") in 1998, by the Ministry of Science and Technology, and the Ministry of Public Health. The "Interim Measures" established a legal system for the collection, storage, export, and research and development of human genetic resources from China. To some extent, "Interim Measures" safeguards the interests of donor and collector. However, "Interim Measures" has not provided for some important systems, such as prior informed consent and benefit sharing. In the absence of the provision on benefit sharing, the requirement of domestic donor and research organizations for benefit sharing cannot be fulfilled, to a large extent. Furthermore, the biotechnological and medical research and development capability of domestic organizations cannot be improved greatly through benefit sharing. The "Interim Measures for the Administration of Human Genetic Resources" need to be revised.

³⁹ Ayo Wahlberg And Ole Doering. 2009. *The Bionet 4th workshop report*. P12. Available at:<http://www.bionet-china.org> [Accessed 20 Aug 2010].

⁴⁰ Ayo Wahlberg And Ole Doering. 2009. *The Bionet 4th workshop report*. P9. Available at:<http://www.bionet-china.org> [Accessed 20 Aug 2010].

⁴¹ Zhan Qimin. 2009. The Development of Biobank for Cancer Research in China. In *Ethical Governance of Biological and Biomedical Research: Chinese-European Co-operation 4th Workshop*. Shenzhen, China: CD

⁴² Ayo Wahlberg And Ole Doering. 2009. *The Bionet 4th workshop report*. P13. Available at:<http://www.bionet-china.org> [Accessed 20 Aug 2010].

⁴³ Bernice Elger, Nikola Biller-Andorno. 2008. *Ethical Issues in Governing Biobanks*, USA: ASHGATE: 20.

⁴⁴ Program of Bioethics. 2009. *The research on the ethical issues and the governance of Biobank in China*. Available at: www.cast.org.cn, org [Accessed 6 Jan 2009].

⁴⁵ Nuffield Council on Bioethics. 2007. *The forensic use of bioinformation: ethical issues*. p102. Available at: <http://www.nuffieldbioethics.org/> [Accessed 18 September 2007].

In recent years, the Chinese legislative agency has begun to modify "Interim Measures." For a good governance mechanism to technological, economic and scientific capability, governments may consider establishing a framework for the monitoring and management of human biobanks. Legislators should explicitly recognize and create provisions with regard to benefit sharing and other needs. Future prospects concerning "Interim Measures" should include general principles, rules, collection and preservation, international cooperation, import and export, regulatory agencies, applicants and approvals, intellectual property, rewards and punishment, and supplementary provisions.^{46 47}

With so many biobanks emerging throughout China, it is important to clarify what governance procedures they are under, which is an arduous task given the poorly developed biobanks situation. In China, some biobanks are commercially owned, others are public. It is difficult for donors to know what biobanks are doing with their samples. Transparent governance procedures and structures may be a good way to provide clarity. The "Interim Measures for the Administration of Human Genetic Resources" should be revised.

The Chinese government has done some work on this. At the end of 2008, the Human Genetic Resources Administration of China (HGRAC) organized a meeting on revising the "Interim Measures for the Administration of Human Genetic Resources", in the year of 2009, the officials of HGRAC investigated the biobanks in Shanghai, to help with the revising.

For the revising, China should have a good governance mechanism for technological, economic and scientific capability. Governments may consider establishing a framework for the monitoring and management of human biobanks. HGRAC should carry out routine duties on all biobanks in China. It is its duty to organize, control and provide access. To take all appropriate measures, whether of a legislative, administrative or other character, an annual report or a website should be provided, and updated regularly.⁴⁸

The revisions should support the principles set out in accordance with laws concerning human rights, and reaffirm the principles established in the Universal Declaration on the Human Genome and Human Rights. Revisions should affirm the principles of equality, justice, solidarity and responsibility as well as respect for human dignity, human rights and fundamental freedoms.

The revising should be based on the National Statement on Ethical Conduct in Research Involving Humans; HUGO Ethics Committee - Statement on Benefit Sharing; HUGO Ethics Committee - Statement on Human Genomic Databases; HUGO Ethics Committee Statement on DNA Sampling: Control and Access; and the International Declaration on Human Genetic Data.

It is necessary to be aware that the collection, processing, use and storage of human genetic data has

potential risks. It is important, therefore, to exercise and observe human rights and fundamental freedoms and respect for human dignity. It should be noted that the interests and welfare of the individual should have priority over the rights and interest of society and research. Finally, efforts are needed to ensure the respect of human dignity and protection of human rights and foundational freedom in the collection, processing, use and storage of human genetic data, in keeping with the requirements of equality, justice and solidarity.

It is worth noting the increasing importance of human genetic data for economic and commercial purposes. There are concerns regarding the special needs and vulnerabilities of developing countries and the need to reinforce national cooperation in the field of human genetics.

It is necessary to consider that the collection, processing, use and storage of human genetic data are of paramount importance for the progress of life sciences and medicine. Also, it is important for applications and uses for non-medical purposes. At the same time, the growing amount of personal data collected makes genuine irretrievability increasingly difficult.

Measures should be supported by action in the sphere of education, training and public information to promote ethics education and training at appropriate levels, and to encourage programs for information and the circulation of knowledge concerning human genetic data and biobanking. A major focus in this regard is the possibility of an integrated approach to capacity building, the continued education and training of staff in ELSI matters, and the qualification of IRB members in China could be complemented by such measures.

Research Principles as Clashing Phantoms

- Carter Reitman and Ann Boyd*
Biology Department, Hood College, 401 Rosemont Ave,
Frederick, MD 21701 USA
Email: boyd@hood.edu

The guidelines formulated in Nuremberg Code and Declaration of Helsinki reflect principles of ethical normative through resting on the shoulders of selected philosophical traditions. Likewise the Belmont Report crafted by the National Commission for the Protection of Human Subjects of Research reflects the same tradition. Professed as universal the principles of autonomy, beneficence, and justice provide a framework for the review of human participation in medical research. Inconsistencies and contradictions may surface in the praxis of reviewing research with the three principles however and it is that possibility we wish to explore herein.

Jessica Pierce writes, "Respect for autonomy has been one of – if not the – guiding principle in medical ethics, and has even become a kind of trump card over other values (1). Informed consent is essential as a process through which a person may willingly, freely, knowingly agree to participate in a research trial accepting the risks of the trial without external pressure or coercion. Beauchamp and Childress argue regarding voluntariness

⁴⁶ Editor. 2008. *The Officials of Chinese Human Genetic Resources Management Office Did Research in Shanghai*. Available at: www.most.gov.cn[Accessed 25 Jan 2008].

⁴⁷ Editor. 2008. *The Beijing Workshop on Revising of "Interim Measures"*. Available at: www.gov.cn[Accessed 5 Dec 2008].

⁴⁸ Herbert Gottweis and Alan Petersen. 2008. *Biobanks-Governance in comparative perspective*. London And New York: Routledge: 24

in consent, "A person acts voluntarily if he or she wills the action without being under the control of another's influence" (2). One may find situations in which research is a requirement of treatment justified on the basis of indirect benefit e.g. advancing research and treatment development for future patients (3). Since the declaration of Helsinki clearly dictates "Participation by competent individuals as subjects in medical research must be voluntary" (4) it may be that strict enforcement of voluntary consent can be perceived as an impediment to progress in medicine. Requiring participation benefits social welfare, and serves individual welfare if the trial participants receive direct benefit. In some protocols that direct benefit is little more than more frequent medical attention. Can a small sacrifice of absolute adherence to the autonomy principle be shaved away for the greater advancement of treatment modalities and if so, when?

Persons with diminished capacity are entitled to protection (5). Poverty is a coercive factor in that access to medical services may be limited wherein individual freedom of choice and opportunity are restricted, obviously compromising conditions in which autonomy is to be exercised: "Access to medical services, regardless of income, is as necessary to individual freedom, opportunity, and self-responsibility as is access to the protective services of fire or police departments" (6).

Thus a paradox arises: if Orentlicher is right in that we may sacrifice some individual autonomy in hopes of moving the research agenda forward and developing treatment for future patients then autonomy is not absolute or sovereign over other considerations such as beneficence or social benefit of new remedies. On the other hand if we oppose Orentlicher's position, holding a primacy view of autonomy as an absolute requirement, we may simultaneously abdicate our duty to respect the moral agency for the vulnerable. This paradox exposes putative struggles when attempting to apply with equal measure universal principles of autonomy, beneficence, and justice.

The Helsinki Accord insists on just distribution, "Medical research involving a disadvantaged or vulnerable population or community is only justified if the research is responsive to the health needs and priorities of this population or community, and if there is a reasonable likelihood that this population or community stands to benefit from the results of the research" (4). The practical implication is that we ought to always pay attention to a fair distribution of benefits and burdens. Therefore the industrialized world's relationship with the non-industrialized world is obligated according to Helsinki to concentrate on research that addresses global health issues. Alex London notes, "ninety percent of the world's research dollars are spent on diseases that affect only ten percent of the world's population" (7).

Research into the most detrimental diseases, HIV, malaria, tuberculosis, requires cooperation and regrettably research in places with high incidence of infection. Conducting research in malaria endemic zones is not strictly speaking a requirement of advancing malaria vaccine development as challenge studies can be done with curative follow up treatment. For efficacy purposes research in high risk populations has some justification, however, if the population is extremely poor and cannot hope to gain access to the drug or vaccine developed in the research study, challenges claims of

justice and beneficence. "The effort to recognize the potential for exploitation and injustice requires elimination of the insidious double standard in medical research that rejects for the rich what is acceptable for the poor" (8).

Seeking to harmonize the Belmont principles in international research is a challenge. Putative conflict between justice and autonomy emerge in the debate between respect for individual choice and social welfare and reflects disagreement about allocation of healthcare resources. To recruit participants, some sponsors of research compensate subjects well, temptingly perhaps. Some individuals may be more prone to enroll in a research study for the compensation, a situation which Carl Elliott has called "Guinea-pigging" (9). The respect for person's principle of autonomy ought to include self as well as other persons, but it is difficult to protect a person from ill-advised choices. Elliott has charged that especially poor populations bear the burden of research and are least likely to reap the future benefits. The antidote is certainly not to enroll subjects randomly across society, so the tension must rest between a just distribution and autonomy.

The tensions among the principles may benefit research of research proposals because it is in seeking to harmonize and balance the principles that the safety of the participant is assured alongside the advancing progress of medical research. While historical, cultural, and individual situations may assert such tensions to collapse into contradictions that undermine the "universality" of the principles it need not be the case (10). Using principles consistently across a wide variety of research studies allows changes in guidelines where needed. The overall goal of the review is the protection and safety of the subjects, to guard against unmerited medical advance at human expense and to advance medical research as efficiently as it is safe to do. Certainly, refinement is needed, when a trial leans too heavily on the strict adherence to autonomy, evidenced by the signed document attesting to the consent of the subject, when it can be clearly shown that said subject had little comprehension of the study (11).

Review committees in host and sponsoring countries have obligations to evaluate the balance and significance of the guiding principles. In the context of international research, the sponsoring country has primary responsibility to certify scientific reliability, whereas the corresponding committee in the host country should have more influence on implementation, taking into consideration local customs and traditions. How else can a determination be made about whether the proposed research is "responsive" to the needs of the community? This model suggests a consensus approach, as recommended by the World Medical Association Council for International Organizations of Medical Sciences (CIOMS) guidelines of 2002 (12). Other than mutual respect and compromise there is no global governance regime with power to enforce the principles or ethical recommendations of ethical review. When the press of unfettered progress in the life sciences industry seeks to reduce regulatory requirements in a free market global economy, the battle lines will be between (13). It is true that conceptions of justice and autonomy dominate the conversation at the local ethical review committee considering a local trial in medical research. Furthermore when two or more ethics committees review one protocol

it is not uncommon for disagreements to arise on how the requirements of ethical review of research are satisfied. Claims of autonomy, beneficence and justice may require pluralistic interpretation in the context of cultural diversity, but these adaptations do not nullify the importance of these principles. It may be that the greater threat to ethical principles is not variability of cultural interpretation but the force of economic and political power.

There are basic human needs that transcend culture. The point of the ethical review is to apply new scientific discoveries for the wellbeing of human persons. If this set of principles gives rise to contradiction and conflict, or fail to bring about the primary goal of protecting the research subject, an alternative proposal is awaited. Cahill is right to observe, "Developments so far show that moral appeals and the insistent advocacy of an ethical framework can have effects on policy, especially when they manage to harness a modicum of self interest to a more inclusive moral agenda. Neither economic nor political structures are immune to concerted, multidimensional efforts to change their orientation" (14). It is no less true for adaptation in guiding principles intended to protect human participants in medical research protocols..

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Ethical Analysis of the Embryonic Stem Cell Controversy

- Francisco D. Lara (Ph.D. in Philosophy from University of Granada), Tenured Lecturer of Ethics, Departamento de Filosofía I, Campus de Cartuja, University of Granada, 18071 Granada, Spain
Email: flara@ugr.es

Abstract

Medical research on human embryonic stem cells has provoked a considerable amount of moral controversy. In this paper, the author critically analyses the arguments in this debate. A theory of moral status that coherently and plausibly advocates the use of embryonic stem cells in therapeutic research is also outlined.

Keywords: Bioethics, Embryonic Structures, Embryonic and Foetal Development, Beginning of Human Life, Personhood.

In recent years, biomedicine has made enormous strides in taking on what is regarded as its greatest challenge, the possibility of eliminating the premature ageing of cells in the human body. This has largely been possible due to the use of human embryo stem cells which are capable of producing both different and identical new cells.

Leaving aside the possible implications of these advances in considerably prolonging human life expectancy, the most significant development, at first sight, is the immense therapeutic potential of stem cells. In the long term, stem cells could be used to replace defective organs and, in the short term, to cure numerous illnesses such as heart disease, Parkinson's and diabetes, which are partly due to the deterioration and loss of certain cells.

However, this promising technique for the alleviation of great human suffering is fraught with problems that have made stem cell research a controversial subject. Although it has been possible to harvest stem cells in the foetus and other parts of the human body, those harvested from the embryo,⁴⁹ which have the greatest therapeutic potential,⁵⁰ can only be obtained through its destruction. In addition, as embryos, particularly from a Catholic standpoint,⁵¹ can be said to be endowed with full moral status, they have a right to live, even though their

⁴⁹ I use the term 'foetus' to refer to the living being present in the womb from the eighth week of human gestation up to birth and use the term 'embryo' to refer to the entity present in the womb from the first week after fertilization, when the zygote is implanted in the wall of the womb, up to the eighth week, when the cerebral sulci are first detected.

⁵⁰ National Institutes of Health, 2006; President's Council on Bioethics, 2004; Weissman, 2002; Lindsay, 2007, 46-7; Devolver, 2005a, 169; and Devolver and Harris, 2007.

⁵¹ See, for example, Doerflinger, 1999; Friend, 2003; Oakley, 2002; and Meyer, 2000.

destruction would save many lives. This position is opposed by those who believe that the embryo has no intrinsic moral significance.

The main aim of this study is to counter many of the arguments used in this debate. Thus, in the first section, I shall cite the justifiable reservations of many experts concerning the possibility of reaping the therapeutic benefits mentioned above without at the same time causing the destruction of embryonic cells. I shall then question the widespread attempt to resolve the controversy by only permitting research that uses the large number of surplus embryos harvested from infertility treatments. After ruling out these approaches to resolve the dispute, I will devote the main body of the study to a critical analysis of the arguments for and against human embryo stem cell research, both of which assume that embryos possess moral status. By the end of the study, I will be able to outline my own position, which, while meeting rigorous standards of coherence and credibility, provides ways of settling the debate around stem cell research.

Do Technical Solutions Currently Exist?

Since this debate is caused by disagreements concerning the moral status of the embryo, many attempts have been made to develop scientific procedures, with promising results in human embryo stem cell research, without destroying the embryo. The three most important of these procedures are discussed below.

The first approach takes as its starting point that lines of human embryo stem cells can be harvested without damaging the embryo. To do this, according to some scientists,⁵² the cells should be extracted not from the inner cell mass of an embryo at the blastocyst stage, which is bound to thwart its development, but rather from the group of eight cells (blastomeres), from which an embryo develops at an earlier stage. It is claimed that if one of these cells is extracted using a technique similar to that used in pre-implantation genetic diagnosis, normal cellular differentiation of the remaining cells would not impede the development of the foetus and later of a human adult. However, despite the hopes raised by the mass media at the time, this technical solution to the debate around the moral status of embryos is as yet more a future possibility than a reality, as attempts to apply this chosen technique successfully have failed up to now.⁵³

The second approach attempts to avoid the use of embryos and instead to increase the efficiency of the stem cells derived from fetuses and adult organisms. However, while recognizing the successful use of non-embryonic stem cells in certain fields, most experts appear to agree that human embryo stem cells offer greater therapeutic potential. This is explained by the

highly versatile nature of these cells and their proven capacity to form *pluripotent* cells for all types of tissues in the human body.⁵⁴ By contrast, adult stem cells are, at best, multi-potent cells, as, despite the many advances made in this field, it is not even clear if they can trans-differentiate or efficiently develop into all types of tissue, which would make them pluripotent. For example, although bone marrow stem cells can generate bone cells and other types of connective tissue, they appear unable to differentiate other types of cells. In addition, adult stem cells do not currently have the same potential as embryonic stem cells to proliferate under research conditions. Although human embryo stem cells can be reproduced during a year or more in the laboratory without differentiation, scientists have not managed to obtain similar results with adult cells. It is worth pointing out that, although foetal stem cells appear to have pluripotent functions, they are at the final stage of their development, unlike human embryo stem cells, which raises problems about their use in research.

A third approach that attempts to resolve the controversy by avoiding the moral status dilemma in relation to embryos could be to reprogram the somatic cells through cytoplasmic factors or direct genetic manipulation in order to return them to their original state and thus as versatile as embryonic cells. However, this innovative procedure of converting somatic cells into pluripotent cells, or even totipotent cells, by using the latest techniques⁵⁵ may have carcinogenic side-effects and may not be appropriate for all therapeutic stem cell research requirements. More importantly, this procedure, with which it is hoped to avoid the controversial use of embryos, displaces rather than resolves the problem. If, as some would argue, embryos deserve protection due to their potential to become human beings, a similar approach should then be applied to cells that have acquired the same potential as an embryo through the use of reprogramming mentioned above.⁵⁶

A Compromise Solution: Surplus Embryos

As the technical approach has failed to settle the debate up to now, some people have wondered whether it might be possible to resolve the dispute by appealing to parts of both opposing positions. Accordingly, some authors have suggested that research with human

⁵² For example, R. Lanza and his research group. On their findings in this regard, see Klimanskaya *et al*, 2006.

⁵³ With regard to the criticism of R. Lanza's research group for their lack of experimental transparency, see Lacadena, 2006. On the other hand, many proponents of ascribing full moral status to embryos are not convinced of the soundness of this technique, given the risks faced by the embryos from which the cells are to be extracted, which, in some cases, may not reach maturity. See, for example, O'Brien, 2006.

⁵⁴ The standard method for obtaining human embryo stem cells involves deriving them from the inherent cell mass of embryos developed on a Petri dish during a period of approximately five days. In this so-called blastocyst phase, the embryo is a microscopic hollow sphere containing around one hundred cells. The human embryo stem cells thus obtained are *pluripotent*, meaning that any type of tissue can be obtained from the cells of the inherent mass except the membrane and placenta tissue which, being necessary for the overall development of the embryo, come from the outer sphere. These cells are not totipotent as, unlike cells extracted from younger embryos, they cannot evolve into a new individual.

⁵⁵ In 2009, researchers in two laboratories in Beijing demonstrated that by using this technique, known as "obtaining induced pluripotent stem cells", they are able to generate not only all types of body tissue but also fully-formed animals (mice in this case). However, they have admitted that some mice suffer from malformations. See Zhou *et al*. 2009; and Gao *et al*, 2009.

⁵⁶ Denker, 2008.

embryo stem cells should always be carried out with surplus embryos harvested from *in vitro* fertilization (IVF) treatments. While some research with these embryos is thus permitted, they would in part be protected by a prohibition to harvest them solely for research purposes.⁵⁷

However, how can the use of surplus embryos in stem cell research be justified while prohibiting the use of those created *ex profeso*? Morally speaking, no major intrinsic differences appear to exist between these two types of embryo. Both can be produced through IVF, have the same composition and hence the same potential to become human beings. It is also difficult to distinguish between these two types of embryo in terms of their symbolic significance, as, given their similar intrinsic characteristics, the way in which they are used will probably have the same impact on how people regard embryos and human life.

Thus, the key to making sense of this alleged difference in moral status can only be found in the intentions of the players involved. It is often argued that, in contrast to harvesting surplus embryos, the creation of embryos for stem cell research purposes indicates that researchers are motivated by the intention to treat them as mere objects, which constitutes a serious lack of respect in their regard. There are two versions of this argument.

The first version, based on the classic double effect doctrine, argues that the destruction of surplus embryos harvested from infertility treatments does not involve any lack of respect, as their destruction is merely a case of collateral damage caused by actions carried out with intent to procreate⁵⁸.

The problem with this version of the argument is that, being based on such a deep-seated and impenetrable phenomenon as human intentionality, the concept of responsibility becomes elastic and could be influenced by ulterior motives. Although fertility techniques are known to generate surplus embryos, responsibility for their destruction can be avoided by claiming that this was an unintended effect of attempted procreation. It could also be argued in a similar way that sacrificing embryos for research purposes is an unintended effect of their creation, whose intention is to save lives.

The second version of the argument, that only embryos created *ex profeso* for research purposes are treated disrespectfully when destroyed, is based on the belief that only these embryos have not had the opportunity to become persons. The surplus embryos, at least at their creation, did have some hope of being implanted in the uterus.

However, in order to show that this argument is clearly unsustainable, some authors have conceived of a situation where the moral differentiation required by the argument would be avoided. We are asked to imagine the possibility that assisted reproduction is unnecessary due to the creation by scientists of a larger than necessary number of embryos for research purposes. In

other words, these surplus embryos, corresponding to the number of embryos successfully implanted in infertility treatments, will be donated to infertile couples who wish to procreate. The number of embryos harvested for research purposes which become people would correspond to the number of embryos used in assisted reproduction which eventually become people. It is possible to conclude that both categories of embryo would have had the same chances of becoming people and that they would therefore have been treated with the same respect. It would then be demonstrated that, contrary to the claim of the proponents of this argument, the creation of an embryo for research purposes does not necessarily involve excessive instrumentalization of the embryo by denying it any possibility of becoming a person.⁵⁹

Nevertheless, apart from the questionable differentiation involved, we have seen that these two versions of the argument, which attempt to distinguish between the treatment of surplus embryos and embryos created for research purposes, can both be criticized given that they are based on a highly flawed principle. According to this principle, the manner in which embryos are used should always be restricted due to the obligation to treat them with the same respect we give to people. However, the comparison between embryos and people on the basis of the concept of respect is problematic. Does it make sense to demand respect for an entity, such as an embryo, which is not autonomous? To what extent is it possible to argue coherently that beings, which are not even aware of their own interests, are treated badly when we decide what to do with them? Only beings, who have a conscious purpose in life and could lose their autonomy through the imposition of our will, can be objects of respect, which is obviously not the case for embryos.⁶⁰

Strictly speaking, although the embryo cannot be an object of respect, this does not rule out the obligation to protect. The requirement to protect may ultimately depend on the importance of the embryo for those who do deserve respect. In fact, the embryo is usually respected mainly for its symbolic value or as an essential element in satisfying the desire to procreate. It is worth noting that the embryo's potential to become a person ascribes it an importance in terms of what it represents, which is not the case for other cells and tissues in the human body. Thus, although the embryo has no conscious concerns of its own and thus no moral status, its use is subject to restrictions, such as the prohibition on its use for trivial purposes (to produce cosmetics or teach biology, for example). However, these restrictions should never be used to condemn as degrading the treatment of an embryo when it is harvested in order, ultimately, to make major advances in curing and preventing a large number of diseases.

Secondly, the moral differentiation between embryos harvested for research purposes and surplus embryos can only be understood by virtue of the role played by the embryo in human reproduction. Consequently, true proponents of this position cannot believe that the very nature of embryos ascribes absolute value and unconditional protection to them. They believe that the

⁵⁷ This is the dominant position in European legislation in countries such as Finland, Sweden and Spain; in commissions of enquiry such as the European Commission on Human Embryo Stem Cell Research (2003 report); and among the majority of people taking part in opinion polls on the issue. In this regard, see Solter *et al.* 2003.

⁵⁸ FitzPatrick, 2003.

⁵⁹ Savulescu, 2002; and Devolver, 2005b.

⁶⁰ Steinbock, 2000, 128-9.

embryo is imbued with extrinsic value by virtue of its involvement or noninvolvement in reproduction. Furthermore, the value bestowed on *in vitro* embryos increases considerably when regarded as the seed of a planned pregnancy and decreases when regarded as a 'surplus' or 'supernumerary' embryo of no value. If the belief that embryos only possess value by virtue of their reproductive role justifies the use of surplus embryos for research purposes, regarded by many as not so serious, it would then be clearly irrational to argue that embryos expressly created for research, without any reproductive project from the outset, deserve more protection than surplus embryos.⁶¹

The Ethics of Humanitarian Homicide

The inconsistency of permitting research only with cell lines from surplus embryos used in artificial reproduction could be due to seeing a problem where it does not exist. Nevertheless, it is possible to advocate unrestricted human embryo stem cell research while recognizing the full moral status of embryos. In this respect, the same convincing ethical arguments are used to sometimes justify the death of one human being for the sake of another's survival when, for example, the death of one Siamese twin is accepted so that the other may survive or when an adult is obliged to abandon a ship which is sinking due to an excessive load. This type of humanitarian homicide is accepted, as everyone loses out if one person is not sacrificed. According to J. Savulescu (2002), this applies in the case of embryos used for therapeutic purposes, whereby, if not used for research, everyone suffers. In his view, stem cell research involves embryos in a kind of survival lottery where some need to be sacrificed in order to find treatments to cure existing adults as well as individuals who will develop from the embryos not chosen.

From a purely rational perspective, this argument is very convincing, given that, if embryos could choose between two possible outcomes, they might be expected to opt for a situation where the risk of disease or premature death could be reduced for everyone by sacrificing a few. However, the sacrifice of some entities with full moral status, as assumed here in relation to embryos, for the sake of others still seems unacceptable, however justifiable. This may be explained by the fact that people sometimes associate, perhaps unconsciously, the acceptability of taking a life for the sake of others with the idea that a person should have no qualms about committing permissible homicide *him/herself* when the situation actually arises. This seems a deeply repulsive act even when it is the only way of saving a large number of lives.

⁶¹ Devolver, 2005a and 2005b. Some authors believe that surplus embryos have less value by virtue of their slim chance of being chosen by a couple and thus becoming people. R. Green (2001 and 2002) even believes that researchers cannot be held responsible for the death of some embryos which, due to their surplus supply, are destined only to be destroyed. N. Agar (2007, 200-1) counters by stating that such an exoneration of responsibility makes no sense if it is based on the assumption that embryos have moral value, as scientists who are supplied with these surplus embryos can either decide not to destroy them and donate them to infertile couples or keep them in storage to provide for future requests.

Nevertheless, when the obligation to kill is more remote and impersonal, unlike the well-known example of B. Williams, where nineteen people were saved by shooting just one individual,⁶² the obligation may become more acceptable in certain other situations. This is the only way to understand how the following situation imagined by J Savulescu could be regarded as not so abhorrent.

"My daughters kissed their real grandfather on the forehead. He was only 58. The two Lifesavers were waiting respectfully at the front door. They would take him to remove his organs.

No one objected to the obligatory organ donation scheme. Everyone stood to gain. The death of one person could provide organs for 10 others. Life expectancy has been increased by 20 years. My two girls owe their lives to kidneys from a donor (...)

I couldn't tell whether my father died from a natural arrhythmia of the heart or whether he was 'chosen'. When the natural organ supply was inadequate to meet demands, the Lifesavers chose a person randomly by computer program. While that person slept, a precisely positioned electromagnetic beam came down from a satellite system in outer space and stopped that person's heart.

Few people were ever killed. And we never knew who was killed and who died naturally. Everyone accepted the new system because everyone had a greater chance of living much longer. Organ transplants were used for all diseases, for all ages.

My daughters waved good-bye as he was wheeled out on a trolley. The death certificate would say, 'Died in his sleep.'

I hoped someone young with children would get one of his organs. He had been in good shape until he died. He had done a lot of exercise. Everyone knows exercise can kill you."⁶³

Doubtless, in a situation like this, the refusal to allow some to die for the sake of others is not so extreme. Many would probably agree with Savulescu's view that this situation would be preferable for those who apply the strictest rationality in a supposedly 'original position' involving a choice between two different types of society. These people may even agree with Savulescu that, given the marked similarities with this imagined world, that other world, where a certain number of embryos are sacrificed in order to reduce the risk of everyone suffering from illnesses and death, should always be preferred.

However, the rational act of choosing to kill a few for the sake of the majority's welfare would still be outweighed by a feeling of revulsion. Our deep-seated instincts with regard to taking life, even when occasioned by a random, impersonal and hidden system, prevent the explicit advocacy of a utilitarian calculus in order to resolve the controversy. It is therefore important to determine what factors need to take precedence when deciding on the rights and wrongs of the situation. Intuition should clearly not have the final say in a philosophical debate where arbitrary judgments are anathema. Intuition can however help us to hone our ethical thinking and oblige us to constantly reassess our theoretical assumptions in order to develop as much as

⁶² This refers to the case of Jim and the Indians outlined in Williams, 1973.

⁶³ Savulescu, 2002, 508-9.

possible the most plausible argument, which is more in line with our strongly held convictions about the correct line of action without, at the same time, eschewing rationality.

In conclusion, humanitarian homicide is regarded as ethically inadmissible due to the application of rational criteria to the recognition of full moral status for embryos. I shall therefore discuss below whether a rejection of this moral recognition could be justified and whether on the basis of this rejection, the stem cell debate can be resolved in a rational and plausible manner. To do this, I shall begin by analyzing the arguments commonly presented in support of the full moral status ascribed to human embryos.

The Individual Identity Argument

To some, the destruction of embryos is a very serious matter, simply because they are human beings at their initial phase of development. Everyone has originally been an embryo, which, in itself, endows embryos with moral status.⁶⁴

However, it is impossible to demonstrate that people have been embryos. To do so, personal identity has to be interpreted as individuality, where identity arises from a unilinear continuity from fertilization to the later developmental stages, which, however, is a questionable assumption. As there is a genetic but no numerical continuity between the zygote and the person, they cannot be regarded as the same individual. The zygote cannot be regarded as a particular individual from the first moment of its existence, as a natural splitting can take place in the days following fertilization and give rise to clonal embryos which, while having the same genome, can develop into different individuals. This is true in the case of twins, who cannot be regarded as numerically identical to the single embryo from which they evolved. In other words, as a result of intercourse, if a zygote is produced, which, for the sake of argument, is called Peter, and the zygote splits into two embryos a few days later, it can no longer be referred to simply as Peter. Neither would it make sense to assert that Peter has suddenly disappeared and that two new beings Paul and Steven have arisen in his place.⁶⁵

⁶⁴ This is the position defended in Lee, 2004a; George and Gómez-Lobo, 2002; Gómez-Lobo, 2004; and Tollefsen, 2001.

⁶⁵ Twinning can also be understood to take place at the moment when Peter, who already existed from conception, is joined by his twin Paul. However, this argument is highly flawed, as it locates the origin of the two beings, Peter and Paul, at two different points of time. This poses a serious difficulty for a position that insists that human beings begin to exist at the moment of conception, which would mean that its proponents would maintain that Paul, just like any twin, is not human. The difficulties inherent in this individual identity argument become more apparent in the light of recent advances in reproductive technology, which enable two embryos to be derived initially from early embryo cell separation which are then fused into a single organism or chimera. In this case, it is questionable whether life began with an individual that later became two individuals and that finally turned into a single individual once again. See Kuhse and Singer, 1990, 66-8. A more elaborate critique of the argument that individual continuity arises at conception can be found in Becker, 1975; Smith and Brogaard, 2003, Brogaard, 2007; and Devolver and Harris, 2007, 154.

This represents a serious problem for those who believe that all human beings come from the zygote arising from fertilization where their identity is thought to begin. In accordance with legislation in many Western countries, it would be more reasonable to argue that a human being begins to exist as an individual fourteen days after fertilization. After this period, gastrulation begins with the appearance of the germinative layers that produce the different tissues and organs, when embryonic cells lose the capacity to generate a fully-formed individual. From this point onwards, twinning can no longer take place in a natural way.

A simpler way of countering the individual identity argument is to point out that if human beings were originally embryos, it would also be possible to argue that they will all be corpses one day. Although the embryo, adult and corpse are clearly different states of the same body, they are not the same individual. Human beings coexist with their body, which begins to function before the human being exists, sometimes survives after death, and can even live on for a long time after death, as in the case of comatose or alienated states, where people are unaware of their environment. In some cases, such as progressive dementia, the loss of awareness is gradual. Although it may be difficult to determine the precise moment when a person ceases to exist, it is generally thought to occur when awareness ends. In such cases, the individual ceases to exist even though the body may continue to show signs of life, as individuals are essentially made up of mind.

Since the conception of a human being as a mind housed in a body helps to establish when existence ceases, this should also enable us to determine when existence begins. As in the case of progressive dementia, we cannot pinpoint the precise moment at which mental awareness ceases to exist, as the capacity for mental awareness is acquired gradually throughout the development of the human organism. Nevertheless, until this mental awareness is acquired, a person cannot meaningfully be said to exist. In addition, since a young embryo lacks mental awareness, we can confidently assert that a person is not destroyed when human embryo stem cell research is carried out.

The Species Membership Argument

Some may object to the personal identity argument by claiming that, regardless of whether an individual begins with the embryo, an embryo is a human being and, for that reason alone, already has the same right to life as any human being.

The main problem with this kind of argument is that it depends on the fundamental premise that membership of a category, a biological species in this case, is, *sui generis*, a sufficient reason for ascription of moral status. This premise is unacceptable if the most basic standards of rational morality are accepted. The morality of our conduct towards others cannot depend *exclusively* on which species group they belong to, but rather, on consistent, non-random, criteria, such as possible harm or exploitation caused to others by human conduct. In other words, a description of human beings, particularly in relation to their capacity to experience harm or disrespectful treatment, enables us to attribute moral status to them. Thus, if extra-terrestrial beings, though not members of the human race, were found to have

feelings, to think rationally, to be able to communicate with earthlings and enter into non-aggression and cooperation agreements, there would be sound reasons to grant them moral status. Denying them moral status on the basis of non-membership of the human race would be as unacceptable as racial or sex discrimination.⁶⁶ It is also possible to criticize the way in which human prejudice is used, not to discriminate against people, but to insist on granting moral status to embryos who, lacking the capacities mentioned above, are merely blessed with so-called membership of the human species.

The Potentiality Argument

The core of the so-called potentiality argument states that embryos are important and are endowed with a moral status, not because they belong to the human species, but because of their potential for feeling and rationality. In other words, if their development is not impeded, embryos will become beings capable of feelings, thought, and communication. By virtue of this inherent potentiality, embryos should also be regarded as possessing the same moral status as human beings.⁶⁷

Though apparently very convincing, this argument contains a fundamental logical flaw, namely that an object or person cannot be ascribed moral status on the basis of their future potential. For example, placing a hen in boiling water and an egg in boiling water cannot be regarded as equivalent, even though an egg has the potential to become a hen. Neither would it be acceptable to claim that because a prince is heir to the throne, he is entitled to the same rights as a king. Likewise, the mere possibility of an embryo becoming a human being should not oblige us to treat it as such.⁶⁸

In my view, this logical flaw is unavoidable although the potentiality argument can be partially maintained if the gap between the embryo and the actual possession of human characteristics is minimized by claiming, for example, that even if the embryo lacks such traits, their acquisition is inevitable if allowed to develop. In other words, given the inevitable passage from potentiality to actualization, it could be argued that the embryo deserves to be treated as *if* it had already fulfilled the conditions required to grant it moral status.

For this argument to be effective, the concept of strong potentiality applied to the embryo first needs to be clarified, because the argument as originally formulated might be trivialized by absurdly concluding that sperm and ova are entitled to the same respect as human beings which they have the potential to become under certain circumstances.⁶⁹

To avoid such excessive conceptual elasticity, an entity could be said to have potentiality in the strong sense of

the term only if it is to some extent responsible for its future development. This 'active potentiality' is not applicable to sperm and ova (considered separately), which require external assistance to realize their potential and to fertilize in order to initiate the process that eventually produces a human being. On the other hand, the embryo does have the active potentiality to become a human being, as, unlike the ovum and sperm gametes, it is genetically configured to become a human being without external interventions unless the process is thwarted.⁷⁰

However, the claim that the embryo qualitatively possesses more human potentiality than gametes can be questioned, even though the embryo is also highly dependent on external factors. Although genetically configured to become a human being, an embryo can only develop if it is healthy, implanted in the womb, receives the appropriate nutrients, is not exposed to toxic substances, and so on. By only considering the embryo's predetermination to develop, as opposed to the passive potentiality of sperm cells, it is possible to forget the crucial role played by extrinsic factors in embryonic development. In other words, if the embryo's gestation in the womb and its surroundings are not considered to be of secondary importance, the embryo can be regarded as highly dependent on external factors and thus lacking a self-developing capacity.⁷¹

The embryo's considerable reliance on external factors has become more evident following recent developments in reproductive technology. Previously, when knowledge of the living embryo only covered the period during implantation in the womb, only non-interference in the gestation process was required for the embryo to become a human being. Due to *in vitro* fertilization (IVF) in particular, living embryos are now known to develop only if all the conditions necessary for transfer to the womb are met, with the chances of successful implantation never exceeding 20 %.

In other words, the observable differences in potentiality between embryos and gametes are no longer significant. Ultimately, the human potentiality of some embryos, specifically those used for research purposes, given their reliance on external factors, will be as limited as that for ova and sperm. Absurdly, this would mean that if such embryos need to be protected by virtue of their potentiality, as some would have us do, ova and sperm should also be rescued in order to save the lives of the human beings they have the potential to become.⁷² If this position were adopted, given recent biotechnological

⁶⁶ See Kuhse and Singer, 1990, 69-71.

⁶⁷ For examples of this argument, see Gómez-Lobo, 2004 and 2005; Knoepfler, 2004; and Lee, 2004b. The same argument is used by Hare (1975 and 1989), Pahl (1987) and Pluhar (1977) to oppose abortion.

⁶⁸ For details of the fallacy of attributing moral status on the sole basis of the entity's potential to acquire the feature that would justify such an attribution, see Boonin, 2003, 45-9.

⁶⁹ How a broad interpretation of the concept of potentiality can render it useless was already recognized by Aristotle in *Metaphysics* (IX, 7, 1048b35-1049b1). More recently, the problem has been discussed by authors such as D. B. Annis (1984) and J. Feinberg (1974, 67-8) in a more pertinent context.

⁷⁰ J. Finnis (1995, 50) sought to differentiate between different types of potentiality and concluded that a qualitatively different potentiality arose after fertilization when a unitary and dynamic organism responsible for its own development was formed. I. Persson (2003) defined this 'active' or 'inherent' potentiality as an internal state that endows an entity with the unique capacity for self-development whenever its natural development is unhindered. This is similar to what S. Buckle (1990) called the 'potential to become' a person that characterizes the foetus and distinguishes it from a gamete, which is only has the 'potential to produce' a person. According to Buckle, what characterizes the 'potential to become' is that it preserves some form of individual identity and so allows an entity to 'undergo changes which are changes to *itself*' (95).

⁷¹ Tooley, 1998.

⁷² Singer and Dawson, 1990; and Singer, 1980, c. 6.

advances, the protection of an infinite number of 'potential' persons would be an arduous task. These potential human beings include those that could evolve from embryonic cells at their initial stage of development and from all the adult cells that might acquire, through nuclear transfer or cellular reprogramming, the capacity to develop into people.⁷³

According to this argument, if these cells have the same chances of developing into people with external assistance as those in *in vitro* embryos, the former would be entitled to the same protection as the latter.⁷⁴

Finally, if potentiality means the 'probability of becoming something', the destruction for the sake of scientific research of embryos said to be persons can only be criticized if, for the sake of coherence, gametes and all somatic cells are also believed to be persons, which nobody, however pro-life, would argue.⁷⁵

It is therefore difficult to define the concept of potentiality in relation to the superior moral status of an embryo as compared with other entities such as gametes. However, there remains the serious theoretical problem of the necessity to treat an entity on the basis of as-yet non-existent characteristics, even though their acquisition is very likely in the future. To obtain a clearer understanding of the problem, it is worth considering the situation, as outlined by M. Tooley (1998, 123), where an ovum and sperm possess considerable potentiality to become a person, a potentiality usually confined to embryos. He imagines that they acquired this potentiality after meeting in a recently activated artificial womb, initially giving rise to fertilization and, after approximately nine months, to the birth of a human baby. In this context, one could ask whether the destruction of the gametes' human potentiality by switching off the artificial womb before fertilization would be morally permissible. If, as many proponents of the potentiality argument believe, this is not an immoral act, the high probability of embryos to become people should not, *per se*, be a reason to grant embryos the right to exist.

Soundness and Common Sense of Argumentation

Having highlighted the inconsistencies in arguments that ascribe full moral status to embryos, I will now outline the arguments of the opposing side in the debate, who believe that embryos do not have moral significance.

⁷³ It could be objected that the potential of human embryos and that of somatic cells are not equivalent as the latter can only become a person through direct intervention either by nuclear transfer or cell reprogramming. However, we actually know that an entity has the potential to become something else if it can do so under certain conditions, one of which is considered to be direct intervention. A somewhat similar argument is developed in Savulescu, 1999, 91.

⁷⁴ J. Harris (1998) thinks that the criticism is more straightforward. He contends that 'the egg and the sperm taken together but as yet un-united have the same potential as the fertilized egg' (50). To the possible objection that an individual's potential and the potential to become an individual are different, Harris responds by saying that such a critique only makes sense if one starts with an almost mystical reverence for the individual. Thus, he asks: 'why is it right to protect individuals with the requisite potential but not pairs or multiples of individuals with the requisite potential?' (51).

⁷⁵ Sagan and Singer, 2007; Savulescu 1999, 91; Denker, 2008; and Devolver and Harris, 2007, 157-60.

I shall also show that this approach is more effective in dealing with the controversy surrounding the therapeutic use of human embryo stem cells.

Firstly, in order to determine possession of moral status, appropriate criteria need to be applied. We have seen that membership of the human species and the potential to be a person are not useful criteria. I therefore suggest we begin on the basis of the widely recognized fundamental ethical principle that human conduct should ultimately be based on respecting and not harming others. It would then be logical to state that something has moral status when entitled to being respected and not to be harmed. In a very broad sense, objects can only be respected or harmed if they have interests. At this point, it is important to define what is meant, in the present case, by 'having an interest in something'. It could be said that there is an interest in something only when there is a potential benefit in possessing something or being affected by an event. However, I am not referring to this benefit when I maintain that interest is an important component of the granting of moral status, but rather to when one desires something because one is aware of the potential benefit. This means, for example, that a human being or a dog is concerned with not suffering in a different way from a tree in a forest with respect to avoiding drought⁷⁶. In both these cases, although the necessity of not suffering or going without water is present, the necessity is valued and desired by the subject in the first case while this is not true in the second case.

According to this ethical argument, we should be concerned with entities, namely sentient beings, which intrinsically have a conscious interest in something. Only they, by virtue of their ability to perceive the harm caused by the non-satisfaction of their interests, can really be harmed by our actions in an ethically significant way. What is present in the harm done to sentient beings, whose conscious interests are not met, but which is not present in the harm done to a plant (for example, when its interest in being watered is unsatisfied) is pain. Sentient beings can suffer physically and mentally through anxiety, frustration and so on when their needs, perceived as interests, are not satisfied.⁷⁷ On the other hand, non-sentient beings may have needs and thus an aspect of well-being, although no unpleasantness is experienced when their needs are thwarted or no enjoyment felt when their needs are satisfied. Consequently, unlike sentient beings, they cannot 'mind' the events that affect them.⁷⁸

Pain, which always involves consciously felt harm caused by unfulfilled needs, must therefore play a decisive role in ethical debates, as it is universally rejected and negatively perceived by all sentient beings. In addition, pain must play a decisive role in ethics if ethics is understood to be based either on the natural

⁷⁶ M. Wilson (1980, 152-3) discusses the distinction between taking an interest and having an interest. See also Sapontzis, 1987, 161-3.

⁷⁷ Something similar is argued by B. Rollin (1981, 40-1).

⁷⁸ This is also argued by P. Singer. See, for example, Singer, 1990, 8-9. M. Tooley, (1972 y 1983), J. Feinberg (1984), B. Steinbock (1992) and D. DeGrazia (1996) have also advocated the capacity to feel as a criterion for granting moral status

feeling of compassion towards victims of suffering or on the rational need to consider the interests of all equally in not suffering and being happy. Therefore, sentient beings must be granted full moral status. The criteria for attributing moral status are based on the inherent formal conditions of the moral phenomenon and the consequent requirement to not cause others suffering due to not taking account of their conscious interests. This approach to determining moral status is very much based on common sense, as even those who believe that moral status is the exclusive domain of human beings have no problem distinguishing between sentient and non-sentient beings. Most people can understand, though may not share, the respect shown to animals which do not wish to suffer or die. However, the same general understanding does not exist in relation to, for example, the outcry, so contrary to common sense, when weeds are uprooted or when microbes are deliberately destroyed through the use of antibiotics to treat flu; if one does consider these actions to be ethically significant, one must ascribe moral status to all living beings for merely being alive. If all life is valued for simply existing, that of a human being, a weed and a virus has equal value. The moral status of sentient beings is so intuitively assumed that it is often bestowed on totally inanimate objects because sentient beings are believed to dwell within these objects. For instance, some philosophers from the Jain tradition claim that moral obligations exist in relation to things such as earth, air, fire, and water, which are thought to be inhabited by small, living, sentient beings that can easily be killed or suffer due to reckless human behavior. In other cultures, there is a belief in the sacredness of a place or object, such as the Uluru, a red sandstone monolith near Alice Springs in Australia, thought to be inhabited by living, sentient beings such as deities or spirits of ancestors.⁷⁹

It thus appears to be ethically justifiable, reasonable and intuitive to believe that, given their psychological capacity for conscious suffering, only sentient beings possess moral status.⁸⁰ Nevertheless, moral status is not distributed equally. It is normal to feel obliged to avoid causing unnecessary human suffering or harm, something which is universally rejected. However, not all sentient beings have a sufficiently high level of consciousness to perceive actions, such as life-

threatening events, as harmful. Therefore, if my reasoning has been correct so far, it would be wrong to speak of a duty to protect the life of beings unable to cherish their own lives or perceive their death in a negative way. Also, if required to choose between inflicting pain on two types of sentient beings, one conscious of itself and the other lacking self-awareness, the former would necessarily take precedence. This way of determining the protection a living being deserves lies at the core of my dual-level approach to moral status, which argues that sentient beings, aware of the meaning of loss of life, possess greater moral status than those to whom it can only cause pain.⁸¹

On the basis of these awareness criteria, we can correctly argue that embryos at the initial stages of development lack moral status. They have no feelings because they lack the necessary physiological mechanisms for minimal awareness of pleasure and pain or the desire for continued existence. To argue therefore on the basis of an embryo's nature alone that we should not cause an embryo to suffer or take its life would be as nonsensical as the moral obligation of rocks not to suffer or be killed.

It is only possible to speak of the right of a foetus, though not of an embryo, not to suffer, when, between week 24 and week 38 of gestation, the foetus can be

⁷⁹Warren, 1997, 6-7.

⁸⁰This would involve questioning the very widespread understanding of ethics as referring to beings that only have a moral duty to those capable of reciprocating in a similar way. In the moral community, there are moral agents who possess a sufficiently high degree of moral rationality to make moral judgments, as well as moral patients, or sentient individuals, who, regardless of their level of moral rationality, can be harmed by the conduct of moral agents. This new theory of moral status, based on the capacity to feel, manages to overcome a serious objection to traditional approaches that associate moral status with the capacity to reason in a moral way. The objection to this belief, known as the 'marginal case argument', points out that if this capacity were the decisive criterion, some humans, who, like children and the mentally handicapped, do not possess this capacity, would lose their moral status. However, the adoption of the capacity to feel as a decisive criterion would involve unreservedly considering these 'marginal' human beings as possessing full moral status. For a more detailed description of this critique, see Pluhar, 1995, 1-122 and especially Dombrowski, 1997

⁸¹M. Benjamin (1987) proposes a similar bi-level sentience-based theory of moral status. He suggests that both persons and 'simple beings' (sentient beings that are not persons) have moral status, but that 'persons, who are characterized as possessing reflexive consciousness, may have a higher status than beings having only simple consciousness' (1987, 483). In his view, we are obliged to take the interests of simple beings into account, but not on an equal basis as those of persons: 'To the extent that persons reluctantly cause pain, suffering and even death to beings possessing simple consciousness in order to meet *important needs*, what they may be justified by appealing to their higher status or greater worth. But, to the extent that persons inflict avoidable pain and suffering on such beings merely to satisfy *trivial tastes or desires*, they pervert their greater capacities' (1987, 483). According to L.W. Sumner (1981), another approach to this problem would be to use a sliding scale of moral status instead of two levels of status. He holds that sentience is a necessary and sufficient condition for moral status; he argues, however, that both sentience and moral status vary in degree such that the level of a being's moral status is proportional to its level of sentience. He states that: 'The animal kingdom presents us with a hierarchy of sentience. Non-sentient beings have no moral standing; among sentient beings the more developed have greater standing than the less developed, the upper limit being occupied by the paradigm of a normal adult human being' (1981, 143-4). These bi-level and sliding-scale theories of moral status base the distinction between entities that have intrinsic importance on only one characteristic (monism), the capacity to feel, thus responding to a pre-rational commitment to an ethic that puts a conveniently agreed solution before consideration of the complexity of moral controversies. They presuppose that analysis of such controversies using only one general criterion makes it easier for rational experts to reach commonly-agreed conclusions. This would almost be impossible to achieve from a multiple criteria standpoint where these criteria could not be articulated in similar terms or decisively compared. In other words, such criteria could not be used to resolve moral controversies.

said to acquire the capacity to feel for the first time⁸². It might even be possible to assume a certain moral status at this point in the gestation process before the foetus actually experiences such sensations, which differs from the moral status recognized for currently sentient beings given that, at approximately week 24, the foetus already has the necessary cerebral structures for awareness of pain and later for self-awareness. The appearance of such physiological structures could bolster the belief that *someone* might be harmed in the future if the life of the foetus is not respected. As the foetus develops this awareness at a later stage in its development, thus becoming a neonatal and adult without substantially changing its characteristics, it could be argued that a potential identity already exists since the physical conditions for consciousness are present. The foetus and the person it is destined to become can be regarded as the same individual. In addition, although the right to life does not properly obtain until the capacity to perceive the harm of dying develops, the potential person would have an interest in the right to life of the foetus.

We therefore need to recognize the right of most developed fetuses not to suffer and a quasi-right to life, which could however be invalidated should it conflict with the important requirements of beings with full moral status.⁸³ By contrast, an embryo does not possess the necessary cerebral structures and functions for consciousness. For that reason and because the natural twinning process might occur at any particular time, the embryo cannot become a neonate without substantial changes taking place. It is therefore senseless to argue that the protection of the embryo's life might fulfil the duty to respect the right to life of a person who has yet to be born.

Nevertheless, this does not mean that embryos are without value. As seen above, although they have no moral status in and of themselves, there may be an indirect reason, unrelated to their own characteristics, to ascribe value to and protect embryos. They merit protection given their participation in the reproductive process and the deep-seated desire of human beings to procreate, which is fundamental to their happiness and necessary for the survival of the species. However, this does not apply to embryos used for research, which are either created specifically for this purpose or are surplus embryos from infertility treatments, which have no value simply because nobody wishes them to satisfy their desire to procreate.

In conclusion, if embryos do not meet the minimal requirements for attribution of moral status and do not have indirect value, as they are not necessary for reproduction, this is an important motive for not objecting to their destruction for the purposes of scientific research,

which aims to improve the welfare of human beings and to save lives.

However, my approach to the issue of stem cell research outlined above must not only be valid in rational terms but also be consistent with bottom-line common sense. This latter requirement is clearly met when situations where embryos are treated as if they had no moral status are generally permitted, as in the case of artificial reproduction.⁸⁴ Only the widely-held belief that an embryo has no value in itself can make sense of why fertility treatment, involving the production of hundreds of thousands of doomed embryos, is frequently carried out and legally permitted. In addition, neither society nor even the 'parents' of embryos act to prevent the death of surplus embryos, which would be unthinkable if they were really thought to possess moral status.⁸⁵

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⁸² For the scientific basis of this assertion regarding the emergence of awareness, see, for example, Seller 1992; and Burgess and Tawia, 1996.

⁸³ Such a perspective could lead to a highly permissive position on abortion and could even justify infanticide. Nevertheless, in the case of infants, only in exceptional situations could their quasi-right to life actually be overridden. The social expediency of protecting children, the emotive reactions they produce in people and the consequent repulsion at the thought of infanticide would make this scenario highly unlikely.

⁸⁴ J. Harris (2003, 362ss.) argues that natural procreation also suggests that embryos have no moral standing. Since up to five embryos are miscarried during each coitus, some already at the blastocyst stage, many embryos are sacrificed to conceive a child. Nevertheless, nobody considers the exploitation of all these embryos as reprehensible, as, according to Harris, we do not consider embryos to be morally significant.

⁸⁵ Proof that even those most opposed to embryonic stem cell research do not regard embryos as beings with moral status is that conservative governments have not simply outlawed such research. In the United States, the George Bush Jnr. government denied public funds for this research but did not ban it. Similarly, the German Federal Parliament in 2002 approved a law that, whilst forbidding German laboratories from obtaining embryonic stem cell lines, allows them to work with such lines provided they were obtained the year prior to the law's enactment.

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