FOOD SECURITY EMERGENCIES AND THE POWER OF EMINENT DOMAIN: A DOMESTIC LEGAL TOOL TO TREAT A GLOBAL PROBLEM

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INTRODUCTION

In 1996, representatives from 185 countries met at the World Food Summit in Rome.[1] The result was the Rome Declaration on Food Security establishing the goal of reducing by half the number of chronically hungry people in the world, a figure that then stood at 800 million people.[2] Its goal embodies the concept of food security: a concept that has generated "approximately 200 definitions and 450 indicators."[3] Food security became a global concern at the 1974 World Food Conference.[4] Since then, one commentator has likened food security's definitional fecundity to the evolution of species in a rain forest: "One minute, we find a single, simple life form; the next, the forest floor is crawling with different species and the air is bright with the flash of multi-colored wings."[5] The meaning of food security was best identified by the Rome Declaration drafters when they said:

> Food security, at the individual, household, national, regional and global levels . . . exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their

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1. U.N. FOOD & AGRIC. ORG. (FAO), REPORT OF THE WORLD FOOD SUMMIT (Nov. 13 - 17 1996) [hereinafter WORLD FOOD SUMMIT], http://www.fao.org/wfs/index_en.htm (last visited Nov. 30, 2005).

2. *Id.* (follow "Documents" hyperlink; then "Rome Declaration on Food Security" hyperlink).

3. John Hoddinott, *Operationalizing Household Food Security in Development Projects: An Introduction* to INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE, TRAINING MATERIALS: FOOD AND NUTRITION POLICY 1-2 (Mar. 1999), http://www.ifpri.org/training/material_food.htm (follow ".pdf" hyperlink at title of report) (last visited Nov. 30, 2005).

4. U.S. DEP'T OF AGRIC. (USDA), FOREIGN AGRIC. SERV., WORLD FOOD SUMMIT: BASIC INFORMATION, http://www.fas.usda.gov/icd/summit/basic.html (last visited Nov. 30, 2005).

5. Simon Maxwell, *Food Security: A Post-Modern Perspective*, 21 FOOD POL'Y 155 (1996).

dietary needs and food preferences for an active and healthy life.[6]

The most food-insecure countries of the world exist in the sub-Saharan region of Africa.[7] There, hunger devastates so many lives.[8] In sub-Saharan Africa, more than 200 million people live with chronic hunger—every single day, right now at this very moment.[9] The consequences of so many hungry people in one vast region are dangerous for us all because global security deteriorates in a food-insecure world.[10] Food security emergencies, or "food insecurity," also impact the developed, wealthy nations. For example, in the United States, 13 million children live in households struggling with hunger.[11] This issue will only compound itself, all around the globe, as the world's population grows in the decades to come.[12]

Food Insecurity: A Deadly, Complex, and Growing Problem

Food insecurity is a complex problem with complex solutions. In

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6. WORLD FOOD SUMMIT, *supra* note 1 (follow "Documents" hyperlink; then follow "World Food Summit Plan of Action" hyperlink).

7. "Sub-Saharan Africa," defined: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Djibouti, Equatorial Guinea Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Nambia, Niger, Réunion, Rwanda, St Helena, São Tomé e Príncipe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Western Sahara, Zaire (Democratic Republic of Congo), Zambia, Zimbabwe (sometimes South Africa is not included). GORDON CONWAY, THE DOUBLY GREEN REVOLUTION: FOOD FOR ALL IN THE 21ST CENTURY xiii (1998).

8. U.S. AGENCY FOR INT'L DEV. (USAID), FAMINE EARLY WARNING NETWORK, EXECUTIVE OVERVIEW OF FOOD SECURITY THREATS IN SUB-SAHARAN AFRICA (Jan. 12, 2005) [hereinafter FEWS NET], http://www.fews.net/resources/gcontent/pdf/1000573.pdf (last visited Nov. 30, 2005).

9. CONCERN WORLDWIDE USA, REPORT ON HUNGER FROM CONCERN CEO TOM ARNOLD, http://www.concernusa.org/news/item.asp?nid=133 (last visited Nov. 30, 2005).

10. Mikail S. Gorbachev, *Foreword* to WORLD WATCH INSTITUTE, STATE OF THE WORLD 2005: REDEFINING GLOBAL SECURITY (2005), http://www.worldwatch.org/pubs/sow/2005 (follow "Foreword" hyperlink) (last visited Nov. 30, 2005). Mr. Gorbachev identified three interrelated challenges facing the world: security, poverty, and environmental degradation. *Id.* This Note will link food insecurity to all three of these challenges.

11. BREAD FOR THE WORLD INSTITUTE, HUNGER BASICS, http://www.bread.org/hungerbasics/index.html (last visited Nov. 30, 2005). For additional statistics on hunger in the United States, *see* AMERICA'S SECOND HARVEST: THE NATION'S FOOD BANK NETWORK, http://www.secondharvest.org/site_content.asp?s=59 (last visited Nov. 30, 2005).

12. KLAUS M. LEISINGER ET. AL., SIX BILLION AND COUNTING: POPULATION AND FOOD SECURITY IN THE 21ST CENTURY ix (2002).

the late 18th century, Thomas Robert Malthus made the grim observation that the world's population increases geometrically while agricultural production only increases arithmetically.[13] Malthus predicted that a drastic decrease in population growth or a steep increase in agricultural productivity must occur, or the world would begin to suffer from the calamites of war, pestilence, plague, and famine.[14] He was skeptical of an increase in agricultural productivity.[15] Increased productivity, however, is exactly what occurred—great improvements in agriculture over the past two centuries helped stave off Malthus' dire prediction.[16] Still, the problem of food security persists. In 2004, Professor Philip Appleman edited a modern-day analysis of Malthus' work. In the introduction, Professor Appleman wrote:

> When Malthus died in 1834, the total population of the world barely exceeded one billion. If he were to return now, in the twenty-first century, he would find a world population that is well over six billion. He would be surprised at that, because he would find it hard to believe that food supplies had increased sufficiently to keep so many people alive. He would be far less surprised to hear that of those six billion people, one billion of them, as many as existed in his own time, are suffering from malnutrition and in danger of starvation.[17]

The pressure from a growing human population is but one source of the food security problem. There are many other causes of food insecurity in sub-Saharan Africa, including natural disasters, like drought and pestilence, and human-made problems, like corruption in government, warfare, and civil strife.[18] Food security transforms into an

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13. Phillip Appleman, *Introduction* to THOMAS ROBERT MALTHUS, AN ESSAY ON THE PRINCIPLE OF POPULATION: INFLUENCES ON MALTHUS, SELECTIONS FROM MALTHUS' WORK, NINETEENTH-CENTURY COMMENT, MALTHUS IN THE TWENTY-FIRST CENTURY xvii (Phillip Appleman ed., 2d ed. 2004) (1976) [hereinafter Appleman].

14. THOMAS ROBERT MALTHUS, AN ESSAY ON THE PRINCIPLE OF POPULATION (1798), *reprinted in part in* Appleman, *supra* note 13, at 54.

15. *Id.* at 62 (N.B. Malthus wrote in the late 18th and early 19th centuries, well prior to scientific and industrial increases in agricultural productivity).

16. C. FORD RUNGE, ET AL., ENDING HUNGER IN OUR LIFETIME: FOOD SECURITY AND GLOBALIZATION 72 (2003).

17. Appleman, *supra* note 13, at xxxii.

18. FAO, GLOBAL INFORMATION AND EARLY WARNING SYSTEM ON FOOD AND AGRICULTURE, COUNTRIES FACING FOOD EMERGENCIES, *in* AFRICA REPORT NO. 2 (July 2003), http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/005/Y9976E/Y9976E00.HTM (follow "Map of Countries Exceptional Food Emergencies" hyperlink) (last visited Nov. 30, 2005).

emergency when its long-term (growing population) and short-term (drought and warfare, e.g.) causes converge. In the time it takes to read this paragraph, fifty human beings were born into the world: human population grows exponentially every single moment of every single day.[19]

Early Developments to Treat Food Insecurity

Because of strides in agricultural productivity, Malthus has been wrong, up to now. Currently, our capacity in agricultural production can sustain the food needs of the human population so that there is food supply for all.[20] However, the most pressing food security problem of today is not the *supply* of food production, but rather the *access to that supply* of food, and, more importantly, access to the technology to increase food production.[21]

Improving agriculture productivity has challenged humankind for over 10,000 years.[22] In relatively modern times, scientific improvements to agriculture now play a distinct role in productivity.[23] "Darwin's theory of evolution, the pure-line theory of Johannson, the mutation theory of de Vries, and the rediscovery of Mendel's Laws of Heredity all contributed to the rise of plant breeding in the beginning of the twentieth century."[24] Accordingly, the application of science and technology are crucial to the continued improvement of agricultural productivity and treatment of food insecurity.

Recent Developments: Biotechnological Research Tools

Since the 1980s, the biotechnology industry has expanded into a

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19. "Today is a very special day: never before have so many people inhabited earth. Yet whenever you read these words, yesterday was special for the same reason. Moreover, the same will be true tomorrow, and the day after that, and every succeeding day for at least the next 50 years. Since you started reading this paragraph, world population has increased by more than 50 people." LEISINGER, *supra* note 12, at ix.

20. RUNGE, *supra* note 16, at 69.

21. *See* AMARTYA SEN, POVERTY AND FAMINES: AN ESSAY ON ENTITLEMENT AND DEPRIVATION 154-66 (1981) (analyzing the causes of starvation, particularly comparing food supply versus access-to-food as the underlying cause of famine) (emphasis added).

22. JOSEPH DEVRIES & GARY TOENNIESSEN, SECURING THE HARVEST: BIOTECHNOLOGY, BREEDING AND SEED SYSTEMS FOR AFRICAN CROPS 1 (2001). "Agriculture: The science, art, or practice of cultivating the soil, producing crops, and raising livestock. . . ." MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 24 (10th ed. 2001). This Note focuses on the crop and plant category of agriculture; this is the context the reader should keep in mind, unless otherwise noted, whenever the term agriculture is used within this Note.

23. RUNGE, *supra* note 16, at 78.

24. *Id.*

multi-billion dollar business.[25] During this time, there has also been a shift in agricultural development within the developed world, from research based in the public-sector to research based in the private-sector.[26] Certainly, private investment in agricultural technology has led to great strides in the development of new biotechnological processes for the research and development (R&D) of new crops, which grow more productively than ever before.[27] These biotechnological processes are called "research tools," or sometimes "upstream" processes; they are used by researchers to improve agricultural crops and increase agricultural productivity.[28] Legally, research tools developed and used to improve agriculture productivity through biotechnology are protected as intellectual property and such proprietary rights may block research to treat food security in sub-Saharan Africa.[29] Unfortunately, this may result in a global problem.

Framing the Issue: Access to Research Technology

Today, agricultural productivity continues to improve largely because of the biotechnological methods used to develop more productive agricultural crops.[30] While improved agricultural productivity addresses the supply-aspect of global food security, the

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25. *See, e.g.,* Ismail Serageldin, *Biotechnology and Food Security in the 21st Century,* 285 SCIENCE 387 (1999). "Total transgenic crop sales [in 1999] grew more than six fold, from U.S. $235 million in 1996 to $1.2 to $1.5 billion in 1998. The market is projected to increase to $3 billion or more in the year 2000, to $6 billion in 2005, and to $20 billion in 2010." *Id.* at 388; *see also* Corrine A. Marasco, *Employment Outlook for 2004: Biotechnology in the Midwest*, 82 CHEM. & ENGINEERING NEWS 45 (2004), *available at* http://pubs.acs.org/cen/employment/8208/8208employment.html (last visited Nov. 30, 2005).

26. Per Pinstrup-Andersen & Marc J. Cohen, *Rich and Poor Country Perspectives on Biology, in* THE FUTURE OF FOOD: BIOTECHNOLOGY MARKETS AND POLICIES IN AN INTERNATIONAL SETTING 32 (Phillip G. Pardey ed., 2001) [hereinafter Andersen & Cohen].

27. *See* Philip G. Pardey et al., *Are Intellectual Property Rights Stifling Agricultural Biotechnology in Developing Countries? in* INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE, 2000-2001 ANNUAL REPORT BIOTECHNOLOGY: TWO PERSPECTIVES 17 (2001) [hereinafter IFPRI REPORT], *available at* http://www.ifpri.org/pubs/books/ar2000/ar2000.pdf (last visited Nov. 30, 2005).

28. Rebecca Eisenberg, *Patenting Research Tools and the Law*, ch. 2 *in* INTELLECTUAL PROPERTY RIGHTS AND RESEARCH TOOLS IN MOLECULAR BIOLOGY (1996) [hereinafter *Patenting Research Tools*], http://www.nap.edu/readingroom/books/property (last visited Nov. 30, 2005).

29. DEVRIES & TOENNIESSEN, *supra* note 22, at 73-74.

30. Lorraine Mitchell, USDA, BIOTECHNOLOGY AND FOOD SECURITY, *in* USDA INFORMATION BULLETIN: ISSUES IN FOOD SECURITY No. 765-11 (June 2001), http://www.ers.usda.gov/publications/aib76511 (follow "Entire Report" hyperlink) (last visited Nov. 30, 2005).

proprietary nature of today's agricultural biotechnology contributes to the access-to-food problem because plant biotechnology patents impede access to new technologies that researchers concerned with today's food security problem need.[31]

Investments in agricultural biotechnology are largely motivated by profits which arise from the intellectual property rights (IPRs) that biotechnology firms enjoy in the results of their R&D.[32] Property rights, like patents in research tool technology, may lead to great profits.[33] Because of the huge investment cost that such R&D demands, the focus in agricultural biotechnology R&D has largely been in the development of crops with high profit-yields on the commercial market.[34] These crops may not address serious food security problems in places like sub-Saharan Africa.[35]

In sub-Saharan Africa, food security is a question of survival for hundreds of millions of people. Improved agricultural productivity must take place in another class of crops which have not enjoyed considerable, modern-day R&D because of their low commercial value in the global marketplace.[36] These are the "staple crops" of the sub-Saharan diet.[37]

Because of the proprietary nature of today's agricultural biotechnology R&D, improvements in nutritious crops that grow well in sub-Saharan Africa's poor soil, such as cassava, may be blocked.[38] Also, the majority of agricultural research conducted on behalf of sub-Saharan Africa is still done in public research facilities.[39] This important work may be hindered by the existence of a layer of IPRs—especially upon the research tools—at the vital R&D stage of

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31. *See, e.g.*, Serageldin, *supra* note 25, at 389.

32. *See* Andersen & Cohen, *supra* note 26, at 32.

33. *Patenting Research Tools*, *supra* note 28.

34. Per Pinstrup-Anderson et al., *World Food Prospects: Critical Issues for the Early Twenty-First Century*, *in* INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE, 2020 VISION: FOOD POLICY REPORT 26 (1999) [hereinafter *World Food Prospects*], *available at* http://www.ifpri.org/pubs/fpr/fpr29.pdf (last visited Nov. 30, 2005).

35. Rebecca J. Nelson et al., *The Role of Genomics Research in Improvement of "Orphan Crops,"* 44 CROP SCI. 1901 (2004) [hereinafter *The Role of Genomics Research*].

36. *Id.*

37. "The [staple] crops include: rice wheat, maize, soybeans cassava, coconut, groundnuts, bananas, beans, potatoes, sorghum, lentils, millet, barley and chickpeas." *See* RUNGE, *supra* note 16, at 243 n.24.

38. *See* DEVRIES & TOENNIESSEN, *supra* note 22, at 147.

39. Michael R. Taylor & Jerry Cayford, *American Patent Policy, Biotechnology, and African Agriculture: The Case for Policy Change*, 17 HARV. J.L. & TECH. 321, 335 (2004).

agricultural biotechnological productivity.[40]

Thus, the question presents itself whether IPRs exacerbate the food insecurity of the developing world—in particular that of sub-Saharan Africa—because the means to research and develop the crops needed to sustain the developing world are blocked by the proprietary nature of modern agricultural biotechnology. There are those who stand ready to conduct the necessary R&D of crops to address the food security needs of regions like sub-Saharan Africa, yet find their progress is chilled by the threat of litigation stemming from intellectual property rights.[41] This problem could have dire international ramifications because global security is at risk in a food insecure world. Part I of this Note examines how food insecurity threatens global security.

Part II will examine ways that food insecurity is treated today through food aid and charity donated from the wealthy countries of the world. Part II will also discuss agricultural productivity: how it was improved tremendously in the twentieth-century using "Green Revolution" methods of agricultural production, and why such methods are not the optimal solution for the crisis ahead in the countries of sub-Saharan Africa.[42]

Besides a reduction in population growth, increased agricultural productivity is the only solution to food insecurity emergencies. Modern agricultural biotechnology is a powerful way to improve agricultural productivity in order to stave off Malthus' dismal predictions. Part III first examines how intellectual property rights function in the United States and throughout the world, and then ends with a narrower focus on how IPRs impact food security research. Part IV details the proposal of this Note, that the power of eminent domain is used to encourage patent holders to license their technology when a national emergency from international instability caused by food insecurity occurs. Finally, this Note concludes that a clear policy which includes the exercise of the government's eminent domain power will not weaken the incentives that IPRs provide for invention and innovation for the American economy.

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40. *Id.* at 389.

41. *See* discussion *infra* Part III.B.

42. M. S. Swaminathan, *Agricultural Production in Africa*, ch. 2 *in* THE CHALLENGES OF AGRICULTURAL PRODUCTION AND FOOD SECURITY IN AFRICA (Olusegun Obasanjo & Hans d'Orville eds., 1992).

I. GLOBAL SECURITY: FREEDOM FROM FEAR AND FREEDOM FROM WANT

Today, more than 842 million people—nearly three times the population of the United States—are chronically hungry.[43] "Chronic hunger is a profound, debilitating human experience that affects the ability of individuals to work productively, think clearly, and resist disease. It also has devastating consequences for society: it drains economies, destabilizes governments, and reaches across international boundaries."[44] The enormous number of chronically hungry people conjures up a critical question: how can we feed these people?

While the rate of population growth has been leveling off in the developed, wealthy countries of the world, the populations of the poorest countries and regions of the world still grow at an alarming pace.[45] Population statisticians refer to this phenomenon as population momentum.[46] Of the seventeen countries whose women average six or more births in a lifetime, all but two are in Africa.[47] In sub-Saharan Africa, millions are undernourished and millions more live on a dollar a day, making it the most poverty-stricken region in the world today.[48]

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43. Dr. Jacques Diouf, Dir.-Gen., FAO, Address to the U.N. at the World Food Day Ceremony (Nov. 18, 2004), http://www.fao.org/english/dg/2004/WFDUN.htm (last visited Nov. 30, 2005); United State Census Bureau, *U.S. Population Clock*, http://factfinder.census.gov/home/saff/main.html?_lang=en (last visited Nov. 30, 2005) (U.S. population = 297,588,523 people at 00:19 G.M.T.).

44. THE HUNGER PROJECT, http://www.thp.org/sac/unit2 (follow "What is Hunger?" hyperlink) (last visited Nov. 30, 2005).

45. U.N. Dep't of Int'l Econ. & Soc. Affairs, Population Division, Population Challenges and Development Goals 41 (2005), http://www.un.org/esa/population/publications/pop_challenges/Population_Challenges.pdf (last visited Nov. 30, 2005).

46. "Population Momentum," defined by one population studies organization as, "The pressure within the population for continued growth even though the birth rate is falling. It is caused by the timelag between children being born and entering their child-bearing years at least 15 years later." *See* JOHN BAINES, ED., PEOPLE: A PROBLEM OF AN ASSET, *Glossary* (1995), http://www.alsagerschool.co.uk/subjects/sub_content/geography/Gpop/HTMLENH/pproblem/xglos.htm (last visited Nov. 30, 2005).

47. JANET LARSON, THE EARTH POLICY INSTITUTE, WORLD POPULATION GREW BY 76 MILLION PEOPLE IN 2004: 3 MILLION ADDED IN THE INDUSTRIAL WORLD AND 73 MILLION IN THE DEVELOPING WORLD, http://www.earth-policy.org/Indcators/Pop/2004.htm (last visited Nov. 30, 2005).

48. U.N., THE MILLENNIUM CAMPAIGN, http://www.milleniumcampaign.org (last visited Nov. 30, 2005) [hereinafter MILLENNIUM CAMPAIGN]. Goal 1 of the Campaign: "Eradicate Extreme Poverty and Hunger," because there are 1.2 billion people who live on less than one dollar per day; 800 million people go to bed hungry every single day; and because more than 30,000 children die from poverty related causes, *every single day*. *Id.* at *Goal 1* (emphasis added, *and* repeated here: 30,000 children die *every single day* from

Chronic hunger and poverty are the rock-and-a-hard-place in between which the people of sub-Saharan Africa find themselves today. One tragedy endlessly feeds upon and exacerbates the other because a person needs money to buy food, but she (or he) cannot earn money when she is chronically hungry.[49] The food security issues of this region are a global concern. Silvio Berlusconi, Prime Minister of Italy, and Chairperson of the 2002 World Food Summit in Rome said, "Together with terrorism, hunger is one of the greatest problems the international community is facing."[50]

Human security is a value which can be broadly defined as both the "freedom from fear" and the "freedom from want."[51] Until recently, security was largely a concern arising out of the conflict among states, i.e. state security, which can be summed up in the phrase "military preparedness."[52] Today, it is recognized that the achievement of freedom from want is as important a goal as the achievement of freedom from fear and countries must arm themselves against such fear by addressing food insecurity.[53] In an editorial in the *Economist*, Kofi Annan, Secretary General of the United Nations, wrote that today's threats to security—terrorism, food security and poverty—are all interrelated so that no one country can tackle them alone.[54]

For example, keeping our food supply secure plays a direct role in achieving freedom from fear. The State Department has been studying the possibilities of food-borne bioterrorism, introducing the national security element to food security concerns.[55] Likewise, in December

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poverty related causes).

49. *See* RUNGE, *supra* note 16, at 14.

50. Silvio Berlusconi, Italian Prime Minister & World Food Summit Chairperson, Closing Remarks Before the World Food Summit: Five Years Later (June 13, 2002), *in* FAO, WORLD FOOD SUMMIT: FIVE YEARS LATER (2002), http://www.fao.org/worldfoodsummit/english/newsroom/news/8580-en.html (last visited Nov. 30, 2005).

51. U.N. DEVELOPMENT PROGRAMME, NEW DIMENSIONS OF HUMAN SECURITY, ch. 2 *in* HUMAN DEVELOPMENT REPORT 24-25 (1994) [hereinafter UNDP], http://hdr.undp.org (follow "HD Reports" hyperlink; then choose "1994") (last visited Nov. 30, 2005).

52. Edward Page & Michael Redclift, *Human Security and the Environment at the New Millennium, Introduction* to HUMAN SECURITY AND THE ENVIRONMENT: INTERNATIONAL COMPARISONS 1 (Edward Page & Michael Redclift eds., 2002) [hereinafter Page & Redclift].

53. *See* UNDP, *supra* note 51, at 24.

54. Kofi Annan, *Courage to Fulfill our Responsibilities*, ECONOMIST, Dec. 2, 2004, http://www.economist.com/opinion/displayStory.cfm?story_id=3445764 (last visited Nov. 30, 2005).

55. Lester M. Crawford, Deputy Comm'r, U.S. Food & Drug Admin., A Conversation on Food Safety and Global Security, Remarks to the Open Forum at the U.S. Dep't of State (Sept. 6, 2002), http://www.state.gov/s/p/of/proc/tr/13454.htm (last visited Nov. 30, 2005).

2004, during his resignation announcement, Tommy Thompson, the former Secretary of the Health and Human Services Department, stated: "For the life of me, I cannot understand why the terrorists have not attacked our food supply, because it is so easy to do."[56] Yet it is a mistake to think of global security only in military terms.[57]

Food security deserves its place in any long-term calculation regarding global security. Widespread chronic hunger causes widespread instability and debilitating poverty and decreases all of our safety, for example from the increased threat from global terrorism.[58] Widespread instability is an unmistakable characteristic of life in sub-Saharan Africa.[59] Food insecurity, therefore, causes global insecurity because widespread instability in places like sub-Saharan Africa threatens all of our safety. Food insecurity in the unstable regions of the world must be taken on now lest we find ourselves facing some far worse danger in the days to come.

A. Fear This: Children as Soldiers

Our concern of food insecurity is a concern for our future. The living embodiment of our future is our children, and food insecurity is one underlying cause of a great tragedy that young people face in our world today: the rise of armies of child soldiers.[60]

In his book on this disturbing topic, P.W. Singer describes the connection a swelling world population has with the degradation of the environment, the depletion of safe drinking water, and the reduction of land suitable for agriculture.[61] Mr. Singer notes that a "third of all children in Africa suffer from severe hunger. By 2010, this figure may rise to as many as half of all African children."[62] Africa is rife with zones of human conflict.[63] Indeed, it is ironic that on a continent with

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56. *Quoted in* Jennifer Wilkins, *Think Globally, Eat Locally*, N.Y. TIMES, Dec. 18, 2004, at A19.

57. CTR. FOR PEACE AND SEC. STUDIES AT GEORGETOWN UNIVERSITY, MISSION STATEMENT, http://cpass.georgetown.edu/mission.htm (last visited Nov. 30, 2005).

58. *See, e.g.*, Ann Veneman, Letter to the Editor, *World Food Summit will help shape the future for all of us*, THE FIN. TIMES (London), June 11, 2002, at 14.

59. *See, e.g.*, WORLD BANK GROUP, MILLENNIUM DEVELOPMENT GOALS, SUB-SAHARAN AFRICA, http://www.developmentgoals.org/Sub-Saharan_Africa.htm (follow "Sub-Saharan Africa" hyperlink) (last visited Nov. 30, 2005).

60. P.W. SINGER, CHILDREN AT WAR 39-40 (2005).

61. *Id.* at 40.

62. *Id.* at 39-40.

63. BUREAU OF INTELLIGENCE AND RESEARCH, U.S. DEP'T OF STATE, ARMS AND CONFLICT IN AFRICA, http://www.state.gov/s/inr/rls/fs/2001/4004.htm (last visited Nov. 30, 2005).

countries "fabulously rich in natural resources, including agriculture," there are so many hungry people.[64] The worst areas of violence in Africa currently witness armed groups totaling over an estimated 100,000 child soldiers; these are soldiers who are often as young as twelve years old.[65]

Many of these children are forced into service, but that is not always the case.[66] Singer states that, in Africa, up to sixty percent of the child soldiers "volunteer" to join, largely due to the economic forces of hunger and poverty.[67] For many of these children, becoming a soldier may be "the only way to guarantee regular meals, clothing, or medical attention."[68] Placing this horrifying scenario into a global perspective, Singer notes a similar ratio of children soldiers enlist in the conflicts in East Asia.[69] The causes of this new element of global conflict are as complex as the causes of food security, and, sadly, in many ways the same.[70] Again and again, there is a link between the pain of poverty and the horror of chronic hunger, and a growing world population that exists in between the two.

B. Want This: A Sustainable Environment

In 1994, the United Nations Development Program, an organization dedicated to sustainable development in the developing world, identified seven main categories of threats to human security: economic, health, environmental, personal, community, political, and food security.[71] Certainly, food security is fundamental to each of the other listed threats because a population that cannot feed itself will not be able to thrive, will be increasingly unhealthy, and will destroy the environment of the land it depends upon in its desperate pursuit of food.

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64. Tom Porteous, *Resolving African Conflicts*, *in* CRIMES OF WAR PROJECT, Oct. 2004, http://www.crimesofwar.org/africa-mag/afr_01_porteos.html (last visited Nov. 30, 2005).

65. SINGER, *supra* note 60, at 20-21; *see also* Kari Huus, *Child Soldiers Add to Liberia Tragedy: Half of Armed Combatants in War-Torn Nation May Be Under 18*, MSNBC NEWS, Aug. 4, 2004, http://www.msnbc.com/news/945577.asp?cp1=1 (last visited Nov. 30, 2005). "There are about 300,000 child soldiers actively fighting *at any given time* around the world." *Id.* (emphasis added).

66. SINGER, *supra* note 60, at 61.

67. *Id.* at 62 (noting that children are legally and traditionally incapable to volunteer to be a soldier).

68. *Id.*

69. *Id.*

70. *Compare* FEWS NET, *supra* note 8 (listing causes of food security), *with The Underlying Causes*, ch. 3 *in* SINGER, *supra* note 60, at 39 (listing causes of children becoming soldiers in armies).

71. UNDP, *supra* note 51.

The lack of food security in sub-Saharan Africa makes it one of the least stable regions of the world.[72] Such instability has a negative effect on global security, especially in the poorer countries of the world, which suffer from major violent conflicts.[73] One cause of this instability can be seen in the connection of food insecurity with the degrading sub-Saharan environment.[74] In the search for sustainable agriculture, the pressures of a growing population have resulted in a reduction of cropland.[75] In Africa, forests are cut down to make grazing pastures, then grazing pastures erode away and become deserts or areas of land incapable of producing any sustainable harvest because the soil has no more nutrients.[76] One commentator, writing about sub-Saharan Africa, noted: "[t]he relationship that exists between human security and environmental degradation is best illustrated in the agricultural sector."[77] Many of the farmers in this region still use the "slash-and-burn" method of subsistence farming.[78] The forests of sub-Saharan Africa are cut down for agriculture because, as will be further discussed below, the African soil quickly loses its ability to sustain plant life so more and more land is needed to grow the same amount of food.[79]

1. *Grinding Poverty and Scarce Resources: The Rwandan Genocide*

Malthus in Africa: Rwanda's Genocide, is the title of chapter ten of Professor Jared Diamond's 2005 book, *Collapse: How Societies Choose to Fail or Succeed*.[80] For Diamond, his abstract understanding of a

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72. UNITED NATIONS INTEGRATED REGIONAL INFORMATION NETWORKS ("IRIN"), http://www.irinnews.org (last visited Nov. 30, 2005). For specific examples, visit the hyperlink, then follow the "Africa"; "Africa Themes"; and "Food Security" hyperlinks.

73. FEN OSLER HAMSON ET AL., MADNESS IN THE MULTITUDE: HUMAN SECURITY AND WORLD DISORDER 151-52 (2002).

74. THE WORLD BANK GROUP, FIGHTING THE POPULATION/AGRICULTURE/ENVIRONMENT NEXUS IN SUB-SAHARAN AFRICA, http://www.worldbank.org/afr/findings/english/find28.htm (last visited on Nov. 30, 2005). *See* discussion *infra* Part II.B.1.

75. LESTER R. BROWN ET AL., BEYOND MALTHUS: NINETEEN DIMENSIONS OF THE POPULATION CHALLENGE 24, 43 (1999).

76. Swaminathan, *supra* note 42.

77. Kwasi Nsiah-Gyabaah, *Human Security and the environment in Sub-Saharan Africa: the challenge of the new millennium*, *in* HUMAN SECURITY AND THE ENVIRONMENT 224, 233 (Edward A. Page ed., 2002).

78. *Id.*

79. ENERGY INFORMATION ADMINISTRATION, SUB-SAHARAN AFRICA: ENVIRONMENTAL ISSUES, Sept. 2003, http://www.eia.doe.gov/emeu/cabs/subafricaenv.pdf (last visited on Nov. 30, 2005). *See* discussion *infra* Part II.B.1.

80. JARED DIAMOND, COLLAPSE: HOW SOCIETIES CHOOSE TO FAIL OR SUCCEED 311 (2005).

swelling population took on new meaning when he visited Rwanda and saw, "day after day, lines of African children along the roadside . . . calling out to passing tourist vehicles for a pencil that they could use in school."[81] He reports that the effects of overpopulation on the environment in Africa is visible in its meager fields denuded by herds of grazing livestock—a landscape eroding away into gullies and streambeds.[82] Professor Diamond argues that, in addition to the more widely-held theory of ethnic hatred, the impact of overpopulation in Rwanda played a part in the 1994 conflict that resulted in the genocide of more than 800,000 people.[83]

Diamond based much of his conclusion on his own observations, and from a study by Dr. Jean-Phillipe Platteau and Catherine André, both of whom conducted a five-year-long "in-depth case study of a highly densely populated area in northwest Rwanda," from 1988 until 1993, just prior to the start of the genocidal killings.[84]

Rwanda is one of the most densely populated regions of the world.[85] To address its food security needs, Rwandan policy was to clear all the available land for agriculture.[86] It is also a country with a long history of ethnic violence between the two dominant ethnic tribes: Hutu and Tutsi.[87] The cycle of this ethnic violence is outside the scope of this Note, however one result of the switch from Tutsi to Hutu political dominance in the early 1990s was the huge displacement of Tutsis, "by death or flight," and more land for an expanding food security need.[88] Even still, the tremendous population growth meant that the lands available for agriculture were soon spent, leaving only the lands in the Rwandan National Parks system free from cultivation.[89]

An aggravating factor throughout sub-Saharan African deforestation is inefficiency in farming, a characteristic true of Rwandan agriculture.[90] There, few modern-day methods are utilized. The farmers

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81. *Id.* Diamond's visit to Rwanda preceded the 1994 conflict and genocide. *Id.*

82. *Id.*

83. *Id.* at 327.

84. Catherine André & Jean-Philippe Platteau, *Land Relations Under Unbearable Stress: Rwanda Caught in the Malthusian Trap*, 34 J. OF ECON. BEHAVIOR & ORG. 1 (1998) (hereinafter André & Platteau).

85. DIAMOND, *supra* note 80, at 313.

86. André & Platteau, *supra* note 84, at 3.

87. GÉRARD PRUNIER, THE RWANDA CRISIS: HISTORY OF A GENOCIDE (1995).

88. André & Platteau, *supra* note 84, at 4.

89. *Id.*

90. *Id.*

still use hand tools and rely upon animal manure for fertilizer.[91] Additionally, sub-Saharan African farming is largely based on "self-sufficiency," that is, farmers in the countries of the region (Rwanda and Kenya are two examples) limit their cultivation to crops with little export value.[92] The climate of Rwanda, however, is unlike most of sub-Saharan Africa. For instance, the climate is more predictable with regular rainfall, which may explain the immense population density.[93] With such a climate, self-sufficiency agriculture is counterintuitive; one would think Rwanda could have a strong agricultural economy. Growing crops for the world market could help treat the poverty endemic to this region of sub-Saharan Africa.[94]

Among other findings, André and Platteau's study showed that between 1988 and 1993 there was widespread unequal land distribution in Rwanda leading to a steep rise in the numbers of people in the "vulnerable sections of the population," that is, those living in poverty.[95] These segments of the population were too numerous to simply become invisible, homeless segments of Rwandan society.[96] The "vicious cycle of poverty" reached across generations where the landless were led to despair and destroyed the traditional system of marriages.[97] Rwandan courts and other methods of adjudicating land conflicts could not cope with the sheer numbers of disaffected people. The social system in Rwanda began to breakdown.[98]

The André and Platteau study began in 1988, and even then, "[d]ue to extreme scarcity of land and to the harsh realities of struggle for bare survival, tensions had developed to such an extent that the social fabric was at risk of falling asunder."[99] With hindsight, we know this risk was realized, and nearly one million people were slaughtered, largely due to long-held ethnic animus, but certainly food insecurity played its deadly part in the tragedy.[100]

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91. *Id.*
92. André & Platteau, *supra* note 84, at 4-5.
93. PRUNIER, *supra* note 87, at 2-3.
94. André & Platteau, *supra* note 84, at 4-5.
95. *Id.* at 28.
96. *Id.* at 33-34.
97. *Id.*
98. André & Platteau, *supra* note 84, at 34.
99. *Id.* at 37.
100. "How could this have happened? [A] failed peace process . . . a politically extreme element that led the country to all-out genocide . . . [g]rinding poverty, competition for scarce resources, and racism all conspired to create the nightmare of the Rwanda genocide." OXFAM AMERICA, *What Did Rwanda Teach Us?*, *available at* http://www.oxfamamerica.org/newsandpublications/news_updates/art7073.html (last visited

2. But, Is It Really an Emergency?

In his study on environmental change and security, J.R. McNeill dismisses the scenario where environmental degradation destabilizes an area so much that "security problems and . . . resource scarcity may lead to war."[101] McNeill finds such a proposition to be a weak one, largely because history has shown society is always able to stay ahead of widespread calamity due, in part, to the slow pace of any major environmental change.[102] This may be so. However, as the events in Rwanda illustrated, the environment can breakdown quite rapidly—almost before one's eyes—when food insecurity drives people to overextend their cropland and to use outmoded agricultural practices.[103] Furthermore, as André and Platteau documented in their study of Rwandan society, overpopulation and land scarcity can contribute to a breakdown of society itself.[104]

Mr. McNeill's assertion closely resembles those of many critics of Malthus.[105] The general argument is: whatever issue we face (e.g., environmental change or overpopulation), it will be introduced at such a pace that we can face the problem long before any calamity sets in.[106]

This wait-and-see view relies on many factors, not least of which are a functioning society and innovations in agricultural productivity. But, today, with up to 300,000 child soldiers fighting in conflicts or wars, and perpetrating terrorist acts, the very fabric of society is under increasing world-wide pressure.[107] Genocide, anarchy, dictatorships, and war are endemic throughout Africa; it is a troubled continent whose problems threaten global security and challenge all of humanity.[108] As

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Nov. 30, 2005).

101. J.R. McNeill, *Environmental Change and Security*, Chap. 8 *in* GRAVE NEW WORLD: SECURITY CHALLENGES IN THE 21ST CENTURY 185 (Michael E. Brown ed.,2003).

102. *Id.*

103. DIAMOND, *supra* note 80, at 320.

104. André & Platteau, *supra* note 84, at 37.

105. *See, e.g., Some Contemporary Critics of Malthusianism*, Part IV, G *in* Appleman, *supra* note 13.

106. *Compare* McNeill, *supra* note 101, at 185 ("until recent centuries major environmental changes happened so infrequently and proceeded so slowly that they normally gave societies ample time to adapt,") *with* JULIAN L. SIMON, THE ULTIMATE RESOURCE (1981). "Nor does past experience give reason to expect natural resources to become more scarce. Rather, if history is any guide, natural resources will progressively become less costly, hence less scarce, and will constitute a smaller proportion of our expenses in future years." SIMON, at 5.

107. SINGER, *supra* note 60, at 3-6 (noting that, until recent times, the separation of children from armed conflict had been one of our longest-held, international norms).

108. *Thousands Died in Africa Yesterday*, Editorial, N.Y. TIMES, Feb. 27, 2005, § 4, at 12 (hereinafter *Thousands Died*).

Juan Somavia, secretary general of the World Social Summit, said: "We've replaced the threat of the nuclear bomb with the threat of a social bomb."[109] Food insecurity is part of the fuse burning to set that bomb off. It is an emergency and we must put that fuse out before it is too late.

II. TREATMENTS FOR FOOD INSECURITY

A. Food Aid

To address food security emergencies, one solution has been the provision of food aid to the developing world. This treatment is practiced by the governments of the developed world,[110] international organizations,[111] nongovernmental organizations,[112] and individuals worldwide.[113] These efforts helped stave off numerous catastrophes.[114] Yet, food aid alone is not enough to help many of the emergencies in sub-Saharan Africa, which increase the food insecurity of the region.[115] While there have been charitable organizations for centuries, such "business as usual" is not a solution to treat the severe food security problem, which may lie ahead. Indeed, food aid may be little more than a "band-aid" treatment for a growing international problem.[116]

Food security is a crisis where the lives of hundreds of millions of people hang in the balance and the security of the world is under threat.[117] The solutions to the food security problem are complex, and

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109. *Quoted in* Michael Renner, *The Global Divide: Socioeconomic Disparities and International Security*, ch. 14 *in* WORLD SECURITY: CHALLENGES FOR A NEW CENTURY 273 (Michael T. Klare & Yogesh Chandrani eds., 3d. ed. 1998).

110. *See, e.g.*, USAID, http://www.usaid.gov (last visited Nov. 30, 2005).

111. *See, e.g.*, FAO, http://www.fao.org (last visited Nov. 30, 2005).

112. *See, e.g.*, Cooperative for Assistance and Relief Everywhere, Inc. (CARE), http://www.care.org (last visited Nov. 30, 2005).

113. *Band Aid Takes Festive Top Spot*, BRITISH BROADCASTING COMPANY (BBC), Dec. 19, 2002 [hereinafter BBC *Bandaid*], http://news.bbc.co.uk/1/hi/entertainment/music/4095227.stm (last visited Nov. 30, 2005).

114. *The Developing Food Security Crisis in Africa Before the House Comm. On Int'l Relations*, 107th Cong. 13 (2002) (statement of Andrew Natsios, Administrator, U.S. Agency for Int'l Development).

115. *See, e.g., Flood Aid 'Not Enough,'* BBC, Feb. 29, 2000, http://news.bbc.co.uk/1/hi/world/africa/660981.stm (last visited Nov. 30, 2005); *See also, Southern Africa: More than Food Aid Needed For Recovery*, IRIN, Jan. 12, 2005, http://www.irinnews.org (follow "Southern Africa" hyperlink; then follow "MORE NEWS" hyperlink; then search date of article cited) (last visited Nov. 30, 2005).

116. BBC *Bandaid*, *supra* note 113.

117. *See Thousands Died*, *supra* note 108. "[T]he continent's most troubled regions . . . challenge not only our common humanity, but global security as well." *Id.* (writing about

in sub-Saharan Africa it is largely recognized that African solutions to African problems must play a major part in addressing this problem.[118] Scientists have shown that some simple, modern-day improvements in sub-Saharan Africa's agriculture could have a "doubling or tripling of food crop yields in just a few years."[119] Charity is admirable and must also continue, but to treat the food security emergency in regions of the world like sub-Saharan Africa where hundreds of millions of people live in poverty, internal agricultural productivity must be increased.

B. Improved Agricultural Productivity

1. The Green Revolution

The two components of Malthus' grim predictions are a rapidly expanding human population and agricultural productivity, which improves at a slower pace than the growth in population.[120] Improved agricultural productivity means that, over time, there is an increase in crop-yields from the same area of land.[121] Advances in the field of food science, particularly those following the lessons gleaned from the lessons of Gregor Mendel in plant breeding, led to improvements in agricultural productivity throughout the twentieth century.[122]

This new productivity in agriculture was applied toward eradicating hunger throughout the developing world in the so-called Green Revolution, in which widespread irrigation, new breeds of agricultural crops, improved fertilizer/pesticide technologies, and post-harvest improvements, such as grain storage, were employed to greatly improve agricultural productivity.[123]

The Green Revolution began in the 1940s, when the Rockefeller Foundation and the Mexican Ministry of Agriculture collaborated to improve Mexico's food security with the development and implementation of new breeds of crops traditional to the Mexican diet,

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Africa).

118. THE AFRICAN UNION, *4th Ordinary Session of the Assembly*, Opening Statement by President Olusegun Obasanjo (January 2005), http://www.africa-union.org (follow "4th African Union Summit" hyperlink; then "Statement By H.E. Chief Olusegun Obasanjo" hyperlink) (last visited Nov. 30, 2005).

119. Jeffrey D. Sachs, Op-Ed., *A Practical Plan to End Poverty*, WASH. POST, Jan. 17, 2005, at A17.

120. MALTHUS, *supra* note 14, at 19.

121. RUNGE, *supra* note 16, at 71.

122. *See* Mark Strauss, *When Malthus Meets Mendel*, 119 FOREIGN POL'Y 105 (2000), *available at* 2000 WLNR 4535665.

123. RUNGE, *supra* note 16, at 81-82.

like wheat, maize, rice, and beans.[124] Then in the 1960s, the International Rice Research Institute was formed by collaboration among the Philippines government and the Rockefeller and Ford Foundations.[125] In his book, *Doubly Green Revolution*, Gordon Conway, former president of the Rockefeller Foundation, distinguished the meaning of the term "Green" as used today versus when the phrase, "Green Revolution" first came about. "Today," wrote Conway, "'Green' signifies the environment; then [the mid-twentieth century] the image it conveyed was of a world covered with luxuriant and productive crops."[126]

Many different technological changes have increased crop yields. Food grains and crops are bred to not only grow more efficiently, thereby increasing yield-to-acre ratios, but also to fare better in storage and transportation, thus maintaining those higher yields for consumption and thereby decreasing a region's food insecurity.[127] All of this will work to preserve land and prevent its degradation by allowing the soil to more efficiently regenerate its nutrient and pH levels.[128] This is how technology increases agricultural productivity.[129] While there have been successes through the use of Green Revolution technologies among many of the developing regions of the world—notably South Asia—most of sub-Saharan Africa has yet to take advantage of these benefits.[130]

There are several reasons why the Green Revolution will not cover sub-Saharan Africa with luxuriant crops: the lack of efficient road systems and the high costs of the energy-intensive farming methods central to the Green Revolution plan, to name two.[131] More fundamental to the problem is the soil of sub-Saharan Africa. It is not suitable for Green Revolution methods of farming.[132] Sub-Saharan Africa's soil has a naturally low and declining fertility that would require billions of dollars worth of chemical fertilizers to correct.[133] What is more, the run-off pollution from the fertilizer would be another input to the

124. CONWAY, *supra* note 7, at 47.

125. *Id.* at 51.

126. *Id.* at 46.

127. RUNGE, *supra* note 16, at 74.

128. CONWAY, *supra* note 7, at 223-25.

129. RUNGE, *supra* note 16, at 74.

130. *World Food Prospects*, *supra* note 34, at 24.

131. EDWARD C. WOLF, BEYOND THE GREEN REVOLUTION: NEW APPROACHES FOR THIRD WORLD AGRICULTURE 7 (1986); *see also* RUNGE, *supra* note 16, at 50.

132. CONWAY, *supra* note 7, at 242-43.

133. *World Food Prospects*, *supra* note 34, at 25.

environmental degradation in sub-Saharan Africa.[134]

In addition to being nutrient-poor, the pH level of sub-Saharan African soil is naturally acidic and becomes increasingly so when fertilizer is used extensively to improve agricultural production.[135] Thus, beyond the run-off pollution from such fertilizer use, the soil itself would become too acidic to support the staple crops essential to the sub-Saharan diet.[136] Finally, many sub-Saharan countries, and their growing populations, are in areas which suffer from recurrent drought.[137] Moving large amounts of water with heavy or poorly managed irrigation systems (both problems for the region) can increase the salinity of sub-Saharan Africa's soil, leading to further environmental degradation.[138]

Therefore, the use of Green Revolution technologies is not the best approach to treat the food insecurity of sub-Saharan Africa. Fortunately, innovations in agricultural biotechnology may lead to new crops, which can thrive in sub-Saharan soil, resist persistent pestilence, reduce the need of chemical fertilizers, require less irrigation, and, most importantly for food security, increase the region's agricultural productivity.

2. *Agricultural Biotechnology*

As we have seen, an increase in agricultural productivity is the only way to increase the food security of some of the most troubled regions of the world. Modern biotechnology can help.[139] With biotechnology, agriculture can be made more productive because bioengineered crops can better survive many of the natural pressures which contribute to food insecurity in Sub-Saharan Africa.[140] Crops can be designed to be drought tolerant or to capture nitrogen from the air, thereby reducing irrigation needs and dependence on fertilizer, and the harm from its resultant run-off.[141] Pesticide use is currently a vital

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134. *Id.* at 29.

135. WOLF, *supra* note 131, at 7.

136. *Id.*

137. *See, e.g.*, WORLD FOOD PROGRAM, AFRICAN HUNGER ALERT, http://www.wfp.org/appeals/africahungeralert (last visited Nov. 30, 2005).

138. Richard MacLean & Joachim Voss, *Allocation of Water Resources in Africa: Potential for Moving Water, in* WATER MANAGEMENT IN AFRICA AND THE MIDDLE EAST: CHALLENGES AND OPPORTUNITIES Part I (Eglal Rached et al. ed., 1996), *available at* http://web.idrc.ca/en/ev-9334-201-1-DO_TOPIC.html (last visited Nov. 30, 2005).

139. Taylor & Cayford, *supra* note 39, at 329.

140. *World Food Prospects*, *supra* note 34, at 27.

141. *Id.*

element of African farming. Summer 2004 witnessed locust swarms, which devastated the crops of the North Western and Sahel regions of Africa.[142] Biotechnology can make plants which are "insect proof."[143]

Agricultural biotechnology is, in many respects, merely the better informed and more organized process of breeding plants. Since the middle twentieth century, with the deeper understanding of the mechanics of DNA, the science of genetics has led to great improvements in agricultural development.[144] For example, through research and development, scientists have been able to isolate a protein secreted by the *Bacillus thuringiensis* (*Bt)* bacterium, which is deadly to many caterpillars while completely harmless to human beings.[145] Researchers at Monsanto, one of the world's largest chemical and biotechnology firms, have been successful in breeding the *Bt* gene into agricultural crops including corn and cotton, thereby making them able to withstand pests like the corn root worm and the cotton boll weevil.[146]

There are many ways in which biotechnology can address food security in sub-Saharan Africa. Most importantly, the potential gains in agricultural productivity could help make the countries of the region self-sufficient.[147] In January 2005, economist Jeffrey Sachs, wrote: "food security in Africa would be a prelude to sustained economic growth."[148] Biotechnology can also assist the malnourished by developing foods with increased mineral and vitamin content.[149] The increased productivity that biotechnology can deliver to the countries of sub-Saharan Africa will have consequences which may address other pressures on food insecurity, such as farmer income and food prices.[150]

As scientists have come to understand the role that genetics play in traits like drought and pest resistance in agricultural crops, private investors have recognized the potential for huge financial gains.[151] The application of modern biotechnology to agriculture has largely benefited

142. FAO, LOCUST INVASION THREATENS SUMMER CROPS IN SAHEL COUNTRIES, http://www.fao.org/newsroom/en/news/2004/49294/index.html (last visited Nov. 30, 2005).

143. DANIEL CHARLES, LORDS OF THE HARVEST: BIOTECH, BIG MONEY, AND THE FUTURE OF FOOD 41 (2001).

144. RUNGE, *supra* note 16, at 79.

145. CHARLES, *supra* note 143, at 42.

146. *Id.* at 123, 193.

147. Andersen & Cohen, *supra* note 26, at 18.

148. Sachs, *supra* note 119.

149. *World Food Prospects*, *supra* note 34, at 27.

150. *Id.*

151. RUNGE, *supra* note 16, at 79.

the industrial farmers of the developed world.[152] Biotechnology corporations focus their efforts on highly profitable crops and developing agricultural innovations which consist "almost entirely of instilling two traits in cotton, corn, or soybeans for sale to farmers in the United States and a few other countries: insect control based on the *Bt* toxin and [herbicide resistance]."[153]

Bioengineered crops are the realized end of investments and large R&D risks. Monsanto reports it invests "$1.5 million a day to look for and bring to market . . . innovative technologies" for its seed and traits products.[154] These crops are the "downstream" results of much research and are developed through the use of the biotechnological research tools, or "upstream" processes.[155] These biotechnological research tools are themselves protected by intellectual property rights, such as patents, and belong to the inventor or corporation who develops them.[156] Most downstream products, e.g. Monsanto's YieldGard® corn, which resists pests, come about from the use of many patented upstream research tools.[157] There is little incentive for agricultural biotechnology firms to use their patented technologies to develop crops targeting food insecurity in developing nations.[158] When it comes to intellectual property, incentive is the key.

In terms of time and money, the risks in agricultural research is high, but the resultant benefits in profits are often commensurately high

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152. RUNGE, *supra* note 16, at 95.

153. Taylor & Cayford, *supra* note 39, at 334.

154. MONSANTO, PRODUCTS AND SOLUTIONS: SETTING THE STANDARD IN THE FIELD [hereinafter MONSANTO P&S], http://www.monsanto.com/monsanto/layout/products/default.asp (last visited Nov. 30, 2005).

155. Downstream: "[T]hose phases of a manufacturing process that follow the biotransformation stage. Refer to the recovery and purification of the product of a fermentation process." Upstream Processes: "[T]hose phases of a manufacturing process that precede the biotransformation stage. Usually refers to the preparation of raw materials for a fermentation process." Biotransformation: "The conversion of one chemical or material into another using a biological catalyst: a near synonym is biocatalysis, and hence the catalyst used is called a biocatalyst." FAO, *Biotechnology in Food and Agriculture, Glossary*, *available at* http://www.fao.org/biotech (follow "Glossary" hyperlink; then the "Downstream"; "Upstream"; and then "Biotransformation" hyperlinks) (last visited Nov. 30, 2005).

156. Generally, with technology, the intellectual property in inventions may be protected "through the federal patent system, state trade secrecy law, or actual secrecy." *See* Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177, 184 (1987).

157. *Monsanto P&S*, *supra* note 154.

158. Taylor and Cayford, *supra* note 39, at 334.

as a result.[159] In the developed countries, the returns are even higher due to the stronger markets and developed structure which supports (and feeds upon) commercially lucrative crops.[160] These returns are profits that result from the intellectual property rights which exist in the downstream crops and upstream technologies of agricultural biotechnology R&D.

For the corporations that invest in these products, intellectual property protection is essential.[161] In 1983, Monsanto's new chief scientist was quick to learn that "[d]iscoveries were useful only if they led to a 'proprietary position'—in plain words, something approaching monopoly."[162] To better grasp the role intellectual property protection has on agricultural biotechnology R&D, the nature and scope of patent protection is discussed in the next Part of this Note.

III. INTELLECTUAL PROPERTY RIGHTS

Black's Law Dictionary defines intellectual property as, "[a] category of intangible rights protecting commercially valuable products of the human intellect."[163] Intellectual property manifests itself in trademarks, copyrights, trade-secrets, and the general right against unfair competition.[164] This Note shall focus on the law of patents, particularly those for downstream biotechnologically-developed agricultural products and the upstream biotechnological research tools used to develop them.

A. Patents

The fundamental purpose for patent protection is the promotion of invention.[165] Patents give inventors an incentive to develop new products for monetary reward.[166] The United States Constitution establishes the legal foundation for American intellectual property law: "Congress shall have Power . . . to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the

159. RUNGE, *supra* note 16, at 89-90.

160. *Id.*

161. Ted C. Fishman, *Manufaketure*, N.Y. TIMES, Jan. 9, 2005, § 6 (Magazine), at 40 (discussing Chinese piracy of intellectual property from knowledge-based industries such as pharmaceutical firms).

162. CHARLES, *supra* note 143, at 20.

163. BLACK'S LAW DICTIONARY 813 (7th ed. 1999).

164. *See id.*

165. ROBERT P. MERGES ET AL., INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 119 (3d ed. 2003).

166. *Id.*

exclusive Right to their respective Writings and Discoveries."[167] Thomas Jefferson authored the first Patent Act, which determined that patentable subject matter would be: "[a]ny new and useful art, machine, manufacture, or composition of matter, or any new or useful improvement thereof."[168]

The 1952 Patent Act kept this language largely unchanged, only replacing the word "art" with "process," and thus re-codified the utility requirement for new inventions to receive patent protection.[169] Beyond utility, an invention must be "novel" in that it is not for a process, machine, manufacture, or composition of matter which has already been used in this country or is the subject of a patent application in this or another country.[170] An invention must also be "non-obvious"—that is to say, the invention cannot be one which would have been developed by someone with the "ordinary skill" required to develop the invention based upon existing technology.[171]

1. Biotechnology Patents

In the 1980 landmark case, *Diamond v. Chakrabarty*, the United States Supreme Court concluded that a bacterium genetically modified to breakdown crude oil was patentable subject matter under 35 U.S.C. § 101.[172] In *Chakrabarty*, the Court reasoned that the plain language of the Patent Act is expansive; that it covers *any* useful process, manufacture or composition of matter.[173] The Court looked to the legislative history of the 1952 Patent Act for evidence that Congress intended patentable subject matter to be expansive.[174] Specifically, the Court noted the Committee Report, which stated patentable subject matter shall "include anything under the sun that is made by man."[175]

This case introduced the incentive necessary to jump-start the then-fledgling biotechnology industry.[176] In his book about the agricultural biotechnology industry, *Lords of the Harvest: Biotech, Big Money, and*

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167. U.S. CONST. art. I, § 8, cl. 8.
168. Act of Feb. 21, 1793, § 1, 1 Stat. 319.
169. 35 U.S.C. § 101 (1952).
170. 35 U.S.C. § 102 (1952).
171. 35 U.S.C. § 103 (1953).
172. Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980).
173. *Id.* at 307 (emphasis supplied).
174. *Id.* at 309.
175. *Id.* (quoting S. Rep. No. 1979, 82d Cong. 2d Sess., 5 (1952)).
176. Linda Greenhouse, *Science May Patent New Forms of Life, Justices Rule, 5 to 4: Dispute on Bacteria: Decision Assists Industry in Bioengineering in a Variety of Projects*, N.Y. TIMES, June 17, 1980, § A, at 1.

the Future of Food, Daniel Charles referred to the time around 1980 as one of a "great biotechnology craze" whereby the promise of a booming biotechnology industry was merely waiting for judicial approval to secure patent protection in order to take-off and grow.[177] Charles noted that one of the early biotechnology companies, Genentech, "was worth half a billion dollars" at the close of the business day it first sold shares of its stock, not long after the *Chakrabarty* decision.[178] Yet, Genentech had no product to sell on that day; no product other than the *potential* of its biotechnological research skills.[179]

Even after *Chakrabarty*, there was uncertainty whether patents would be granted for *agricultural products* developed through biotechnological research. In 1985, the Board of Patent Appeals and Interferences answered this question in the affirmative when it approved a patent application for corn genetically modified with increased levels of tryptophan, an "essential amino acid."[180] There, the Board followed the *Chakrabarty* ruling that anything "made by man under the sun" was patentable subject matter.[181]

By the end of the twentieth century, biotechnology was an industry well on its way to prosperity.[182] Success and fortune aside, however, agricultural biotechnology has not been viewed positively by all and some controversy surrounds the use of genetic engineering in agriculture.[183] The two general sources of controversy are: first, the concern that manipulation of plant genomes will result in environmental catastrophe with dangerous consequences for human health; and,

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177. CHARLES, *supra* note 143, at 10.

178. *Id.* at 11.

179. *See id.* (emphasis supplied).

180. *Ex Parte* Hibberd, 227 U.S.P.Q. (BNA) 443; MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 1265 (10th ed. 2001) (defining "tryptophan"). *Hibberd* was largely followed in a twenty-first century U.S. Supreme Court decision which answered in the affirmative whether utility patents for new plant varieties may be issued under 35 U.S.C. § 101. J.E.M. AG Supply v. Pioneer HI-Bred Int'l, 534 U.S. 124 (2001).

181. *Hibberd,* 227 U.S.P.Q. (BNA) 443, *supra* note 180.

182. Michael J. Malinowski, *The Secret to U.S. Success in Biotechnology*, Comment *in* CENTER FOR INTERNATIONAL DEVELOPMENT AT HARVARD UNIVERSITY: SCIENCE, TECHNOLOGY AND INNOVATION, http://www.cid.harvard.edu/cidbiotech/comments/comments14.htm (last visited on Nov. 30, 2005).

183. "Many companies and universities throughout the world are seeking to file patents on gene sequences and proteins. Questions remain, however, over the moral implications of protecting rights to property in this kind of way." THE NUFFIELD COUNCIL ON BIOETHICS, *The Ethics of Patenting DNA* (hereinafter NUFFIELD COUNCIL), *available at* http://www.nuffieldbioethics.org/go/ourwork/patentingdna/introduction (last visited Nov. 30, 2005).

second, biotechnology will result in the privatization of the fundamental mechanics of life itself.[184] Both concerns are related to the issues of global food security. The controversies regarding the environment and potential ill health effects have been the subject of much debate and will continue elsewhere, for they exist outside of the scope of this Note.[185] The proprietary concerns attendant with biotechnology will be further examined below.[186]

2. The Scope of Patent Rights Provides Social Benefits and Introduces Social Costs

Certain parameters define the scope of patent rights: their limited duration and their breadth of coverage.[187] Broad patent rights are those which cover several facets of a given technology.[188]

Agricultural biotechnology patents may provide proprietary rights in the technology that results in downstream products, such as a type of corn, and also in the upstream research tools required to develop these new crops.[189] Agricultural biotechnological research tools include living organisms and their "gene traits, transformation tools, and germplasms, all of which may be patented."[190] In agricultural biotechnological research, a patent grants broad property rights when it covers certain upstream research tools, like a particular gene trait.[191] Such a patented gene, say one with the trait for pest resistance, has broad implications

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184. RUNGE, *supra* note 16, at 92.

185. *See, e.g.,* NUFFIELD COUNCIL, *supra* note 183.

186. Some critics of agricultural biotechnology and intellectual property rights find that problems result from neo-colonialism whereby the developed world (former colonists) take the germplasm of the developing world (former colonies), alter the character of the germplasm through biotechnology, block access to these new "products" with intellectual property rights (to which the developing world remains largely an outsider) and make profits selling the new products back to the developing world. *See, e.g.,* Lara E. Ewens, Note, *Seed Wars: Biotechnology, Intellectual Property, and the Quest for High Yield Seeds*, 23 B.C. INT'L & COMP L. REV. 285 (2000); *see generally* VANDANA SHIVA, BIOPIRACY: THE PLUNDER OF NATURE AND KNOWLEDGE (1997) (cited in Ewens, *supra*).

187. John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 444 (2004).

188. *Id.* at 440 (describing the "prospect" theory of patents introduced by Edmund Kitch in his article, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977)); *see also*, Natasha N. Aljalian, *The Role of Patent Scope in Biopharmaceutical Patents*, 11 B.U. J. SCI. & TECH. L. 1, 16-21 (2005) (describing the scope of patent rights).

189. Taylor & Cayford, *supra* note 39, at 348.

190. *Id.*

191. COMMISSION ON INTELLECTUAL PROPERTY RIGHTS, INTEGRATING INTELLECTUAL PROPERTY RIGHTS AND DEVELOPMENT POLICY, FINAL REPORT 64 (2002) [hereinafter IPR COMMISSION], www.iprcommission.org/papers/pdfs/final_report/CIPRfullfinal.pdf (last visited Nov. 30, 2005).

on R&D because this gene may also be the vector, or mechanism of introducing other traits into any number of "potential varieties or crops incorporating the [same] gene."[192] This is all to say, the benefits of owning the rights to this one gene are far from limited to only one downstream product.[193]

Beyond the incentives patents provide for new inventions,[194] another social benefit exists in the statutory requirement for public disclosure of the invention which allows for additional innovation in technology.[195] Disclosure introduces efficiency to society by reducing search costs because disclosure makes it reasonably well known who owns the rights to what invention, that is, there is clarity of title.[196]

All of these characteristics—motivation for invention, disclosure for innovation, and efficiency from the clarity of title—serve the public policies where we want a forward moving and dynamic society. However, with agricultural biotechnology, a tension exists between inventor and innovator because the inventor may lose profits when others use the inventor's new technology to innovate new products with the inventor's new, patented technology.[197] This tension may complicate matters for food security R&D.

The breadth of patents on upstream agricultural biotechnological research tools may block research when many of these tools are held by a large number of patent holders or licensees.[198] This problem eliminates the social benefit of reduced search costs because "it can be difficult or impossible for potential users [innovators] to successfully negotiate with all the relevant parties" who hold the relevant patents.[199] Agricultural biotechnological and chemical companies have acquired or merged with seed companies and other research firms, reducing the number of patent holders of upstream research tool technology.[200] This

192. *Id.*

193. *Id.*

194. *See* discussion *infra* Part IV.A and B.1.

195. Patent applications must be written with such description that one skilled in the art of the invention to which the application pertains will be able to "make and use" said invention. 35 U.S.C. §112. *See also*, IFPRI REPORT, *supra* note 27, at 14.

196. IFPRI REPORT, *supra* note 27, at 14.

197. *Id.* Unless otherwise stated, for the purpose of this Note, the word "inventor" means an agricultural biotechnology or chemical corporation. These are the dominant patent holders in this industry.

198. *Id.*

199. *Id.*

200. *See* John L. King, *Concentration and Technology in Agriculture Input Industries*, USDA Agriculture Information Bulletin, No. 763, at 5 (March 2001), *available at* http://www.ers.usda.gov/publications/aib763 (follow link to "Entire Report") (last visited

reduces freedom-to-operate issues for the few patent holders because they bought up all the patent rights and have consolidated them within their own patent portfolios.[201]

Researchers, who seek to develop new agricultural products to address the food security problems in sub-Saharan Africa, for example researchers in universities, do not directly benefit from the increasing role of intellectual property rights in agricultural biotechnological research and development because profits are not their only motivation.[202] This is to say, the scope of patent rights may introduce social costs as well as provide for social benefits.

The costs researchers face may come when they find they lack the "freedom to operate" in their work since there are patents that block access to the research tools they need for their work.[203] The duration of a patent in the United States is twenty years, but its overall scope, particularly when it covers an agricultural research tool, is much more difficult to quantify.[204] This is an example of the "Blocking Patents" phenomenon.[205] Still, it has been noted that other researchers (or innovators) focused on treating food security issues who work in countries outside of the jurisdiction of the country offering intellectual property protection are not *really* restrained in accessing the needed technology because those property rights do not cross borders.[206] This topic will be treated in the next Part of this Note.

3. *International Intellectual Property Rights*

"There is no such thing as an international patent."[207] When a patent is issued in one country, it conveys intellectual property rights in the jurisdiction of that country alone.[208] Firms rarely obtain patents in developing countries; either because of cost, or because there is no available patent regime to adequately protect these property rights.[209]

Nov. 30, 2005).

201. DEVRIES & TOENNIESSEN, supra note 22, at 73 (noting in 2001 the private sector of agricultural biotechnology was an oligopoly of five major firms).

202. *Id.* at 73-74.

203. Carol Nottenburg, et al., *Addressing Freedom-to-Operate Questions for International Agricultural R&D*, ch. 6 *in* THE FUTURE OF FOOD, *supra* note 26 [hereinafter Nottenburg].

204. *Id.*

205. Taylor & Cayford, *supra* note 39, at 343.

206. IFPRI REPORT, *supra* note 27, at 14.

207. Nottenburg, *supra* note 203, at 104.

208. *Id.*

209. *Id.* at 105.

Because agricultural biotechnology firms generally do not patent their technology in developing countries, these countries are largely "denied access to the latest technological advancements, except in some cases as markets for such new products [derived from those advancements]."[210] This does not, of course, mean that there are no international legal tools to protect intellectual property rights.

a. The Agreement on Trade-Related Aspects of Intellectual Property Rights

The harmonization of intellectual property protection between states has been under development for more than one hundred years.[211] One of the latest developments in IPR harmonization is the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), part of the treaty which established the World Trade Organization (WTO) in 1994.[212] There are currently 148 members of the WTO, including most of the countries in sub-Saharan Africa.[213] Members of the WTO must comply with TRIPS.[214] In 2001, the United Kingdom appointed a commission to examine how intellectual property regimes throughout the world could be designed so as to benefit the developing countries "within the context of international agreements, including TRIPS."[215]

This Commission on Intellectual Property Rights discussed several TRIPS issues in their comprehensive, final report.[216] Among these issues were the questions of how broad patents should be on living

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210. R. David Kryder et al., *The Intellectual and Technical Property Components of pro-Vitamin A Rice (GoldenRice™): A Preliminary Freedom-To-Operate Review*, ISAAA Briefs No. 20, at 33 (2000) [hereinafter Kryder], *available at* http://www.isaaa.org (follow path: "Resources," "Publications," "View/ISAAA Briefs," then "Briefs No. 20 - 2000) (last visited Nov. 30, 2005).

211. IPR COMMISSION, *supra* note 191, at 5. "States" in this Note means "Nations."

212. *Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization*, Annex 1C, LEGAL INSTRUMENTS—RESULTS OF THE URUGUAY ROUND vol. 31, 33 I.L.M. 81 (1994) [hereinafter TRIPS].

213. WORLD TRADE ORGANIZATION, *Understanding the WTO: The Organization*, http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm (last visited Nov. 30, 2005). "The WTO recognizes as least-developed countries (LDCs) those countries which have been designated as such by the United Nations. There are currently 50 least-developed countries on the UN list, 32 of which to date have become WTO members." WORLD TRADE ORGANIZATION, *Understanding the WTO: Least Developed Countries*, http://www.wto.org/english/thewto_e/whatis_e/tif_e/org7_e.htm (last visited Nov. 30, 2005).

214. *The World Trade Organization and the TRIPS Agreement*, Box 0.1 *in* IPR COMMISSION, *supra* note 191, at 3 [hereinafter Box 0.1 *in* IPR COMMISSION].

215. John Barton, *Preface to the* IPR COMMISSION, *supra* note 191.

216. Box 0.1 *in* IPR COMMISSION, *supra* note 214.

organisms and whether intellectual property protection must be available for plant technology, including how such a requirement will fall in with other international agreements on this matter, e.g., the Convention on Biological Diversity.[217]

The Commission determined that stronger intellectual property rights are not optimal for the least developed nations because until such nations gain some economic strength, weaker intellectual property protection will actually stimulate more rapid economic growth.[218] By looking at the number of patents issued to residents and non-residents of several developing countries, the Commission was able to determine the benefits enjoyed by the nationals within those countries and found that IPRs benefited most those patent owners who are not residents of the developing country.[219]

Under TRIPS, member states must provide patents for "any inventions, whether [downstream] products or [upstream] processes, in all fields of technology.[220] Member states may exclude, among other things, plants from patent protection, with this caveat: "Members shall provide for the protection of plant varieties either by patent or by an effective *sui generis* system or any combination thereof."[221]

b. TRIPS and Developing Countries

The IPR Commission advocated that developing countries utilize the *sui generis* approach because patents place restrictions on farmers to use seeds protected by such strong proprietary protection, like patents. Thus, while there is no such thing as an international patent, the century-long drive towards harmonizing intellectual property protection has led to agreements such as TRIPS, which will introduce some form of intellectual property protection throughout most of the world. Such protection may not be the best thing for food insecurity in sub-Saharan Africa because the research needed to develop crops may be blocked by strong patent or proprietary protection.

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217. *Id.*; U.N. Environment Programme, *Convention on Biological Diversity*, *available at* http://www.biodiv.org/ (last visited Nov. 30, 2005).

218. IPR COMMISSION, *supra* note 191, at 22.

219. *E.g.*, "In sub-Saharan Africa in 1998 (excluding South Africa), 35 patents were granted to residents compared to 741 to non-residents. . . . In the US, the corresponding figures were 80,292 [residents] and 67,228 [non-residents]." *Id.*

220. TRIPS, *supra* note 212, at § 5, art. 27(1).

221. *Id.* at § 5, art. 27(3)(b).

B. Intellectual Property Rights Block Access To Food Security Research

1. Blocking Patents

When a patent covers an agricultural biotechnological research tool with wide application in agricultural research to address food insecurity in developing countries, then that patent may block important food security research and innovation.[222] A "blocking patents" strategy is one in which a firm in a complex industry, such as agricultural biotechnology, will build up its portfolio of patents to create "bargaining chips" for cross-licensing negotiations with rival firms and to also secure the freedom-to-operate to develop new inventions using the needed technology protected by their rivals' patents.[223] According to one survey of complex industries, this "blocking" capability served as motivation for patenting technology second only to the motivation in securing protection from copying.[224] It has been noted that when firms patent to block their rivals, they do so "to hold their rivals hostage by controlling technology that [their rivals] need."[225]

It is the threat of legal action, which blocks the use of patented technology.[226] Firms can counter such threats by holding patents of their own: patents that their rivals may wish to utilize in their own product development.[227] Therefore, in complex industries, blocking patents can be used offensively or defensively as a counter-measure to a threatened infringement suit.[228]

This blocking phenomenon chills agricultural research. For example, one public research organization in Africa, the International Institute for Tropical Agriculture (IITA), headquartered in Nigeria, has been calling for assistance in increasing its capacity to conduct biotechnological research.[229] The main thrust of the call was for

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222. Taylor & Cayford, *supra* note 39, at 348.

223. Wesley M. Cohen et al., *Protecting Their Intellectual Property Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not), Working Paper 7552, in* NATIONAL BUREAU OF ECONOMIC RESEARCH, WORKING PAPER SERIES 22 (2000) [hereinafter Cohen], www.nber.org/papers/w7552 (page numbers refer to .pdf file) (last visited Nov. 30, 2005).

224. *Id.* at 21.

225. *Id.* at 26.

226. *Id.*

227. Cohen, *supra* note 223, at 26.

228. *Id.* at 27.

229. *Close the African Biotech Gap, Newsletter*, INT'L INST. OF TROPICAL AGRIC., (IITA, Ibadan, Nig.) Nov. 19, 2003 [hereinafter IITA], www.iita.org/news/bio_conf.htm

increased research capacity (researchers, equipment, etc.), but IITA also stated the need for legislation on intellectual property rights, "for countries to take full advantage of biotechnological tools."[230] Unlike private agricultural biotechnological firms, researchers at IITA do not hold portfolios of patents on their technology.[231] As has been stated, there has been little agricultural biotechnological research on the staple crops which thrive in sub-Saharan Africa's soil with its low fertility, for example on cassava.[232] Patents which block such research from going forward blocks the research needed to treat food insecurity.

IITA is one of fifteen public research centers worldwide that together comprise the Consultative Group on International Agricultural Research (CGIAR), a result of the Green Revolution, founded in 1971.[233] When the research centers of CGIAR seek to derive new agricultural crops through biotechnology, say by using upstream research tools, the number and breadth of the patents covering today's technology make establishing clarity in "freedom to operate . . . an onerous task."[234]

Yet, many patent holders waive their blocking rights by freeing up access to new technology and products. An example is the Vitamin A enriched, *GoldenRice*™, which was developed with technology covered by patents owned by dozens of corporations and researchers.[235] To lawfully produce such a downstream product could require obtaining licenses from upwards of more than forty enforceable patents.[236] Because there is no international patent, and the components used to

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(last visited Nov. 30, 2005).

230. *Id.*

231. IITA, POLICY OF IITA ON INTELLECTUAL PROPERTY, http://www.iita.org/info/policy.pdf (last visited Nov. 30, 2005). "IITA aims to enhance the food security, income, and well being of [the] resource-poor people . . . of sub-Saharan Africa. . . . IITA considers that excluding others from accessing IITA research products [i.e., research tools] is contradictory to its mandate and mission. Therefore, IITA does not seek to secure patents. . . ." *Id.* at 1.

232. *The Role of Genomics Research*, *supra* note 35, at 1901.

233. CONSULTATIVE GROUP ON AGRICULTURAL RESEARCH, www.cgiar.org (follow "Who We Are" hyperlink) (last visited Nov. 30, 2005). For more information on the Green Revolution, *see* discussion *supra* Part II.B.1.

234. *IP Newsletter*, CENTER FOR THE APPLICATION OF MOLECULAR BIOLOGY TO INTERNATIONAL AGRICULTURE (CAMBIA) (Jan. 2000), http://www.cambiaip.org/cambiaIP/Newsletters/News_archive/news_jan_2000.htm (last visited Nov. 30, 2005).

235. Kryder, *supra* note 210, at 33.

236. *Id.* There were up to seventy patents on various stages of research on *GoldenRice*™, but, at most, only forty or so could be enforced in any one country. *Id.* This confusing dynamic is one example of the difficulty in using patented agricultural biotechnology.

develop *GoldenRice*™ are not patented in every country, some countries will have fewer enforceable patents than others.[237] That is, the laws of those countries would require fewer licenses to use and sell rice grown with *GoldenRice*™ technology.

What is at issue, then, is whether researchers whose goals and missions are to treat food insecurity have the freedom-to-operate in their research to develop crops which can satisfy their goals.

2. *Researchers Need the Freedom-to-Operate*

Even though there is no such thing as an international patent, widespread intellectual property rights may be blocking research which could benefit sub-Saharan Africa.[238] Many researchers may not have the freedom-to-operate and conduct research on crops which may best treat food insecurity in sub-Saharan Africa.[239] While the use of technology patented elsewhere may be legal in an African country, patents still chill research from going forward.[240] Less research occurs in agriculture for the sub-Saharan region because the African researchers cannot share their developments with researchers from the developed world. African research is blocked by intellectual property rights.[241] What is more, the focus of international trade is gearing towards more IPR protection. This means the freedom-to-operate with patented agricultural biotechnological research technology may become more difficult for researchers working in (or for) the benefit of farmers in sub-Saharan Africa.[242]

Even when patent owners want to "give it away," patents and intellectual property rights chill researchers' freedom-to-operate. To illustrate, we shall return to *GoldenRice*™, whose inventors and patent holders have been seeking for years to "donate" for "humanitarian use" (i.e. use that is free of most intellectual property protection) their technology to poor farmers in the developing world.[243]

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237. Kryder, *supra* note 210, at 33.

238. Nottenburg, *supra* note 203, at 105; *see also* discussion *supra* Part III.B.1.

239. "Freedom-to-Operate" refers to the ability to use patented or otherwise protected technology. Ways of "mitigating" barriers in the freedom-to-operate include: "taking out licenses on patents that may block research, inventing around patents, shifting to areas of research where there is more freedom to operate, moving research offshore, or simply infringing." *See* IPR COMMISSION, *supra* note 191, at 127. For examples of staple crops in the sub-Saharan diet, *see* RUNGE, *supra* note 16, at 243 n.24.

240. DEVRIES & TOENNIESSEN, *supra* note 22, at 73-74.

241. *Id.*

242. *Id.* at 72-73.

243. Ingo Potrykus, Daily Newsletter, *Experience from the Humanitarian Golden Rice Project: Extreme Precautionary Regulation Prevents Use of Green Biotechnology in Public*

3. *You Can't Even Give It Away*

Ingo Potrykus was one of the chief scientists on the *GoldenRice*™ project in Switzerland.[244] In 2004, Mr. Potrykus published an essay highlighting the benefits of *GoldenRice*™ and the "humanitarian" motives behind its hoped-for donation.[245] Of the seventy patents needed to produce this product, most are held by the "private sector."[246] The private-sector patent owners were clear that a donation of *GoldenRice*™ for "humanitarian use" means uses which generates less than $10,000 in sales.[247]

GoldenRice™ has taken nearly thirty years to develop—most notably ten of those years were necessary to overcome "a series of GMO-specific hurdles such as IPRs."[248] That is, it has taken ten years for a sophisticated research institution in one of the wealthiest, most developed countries in the world to negotiate through the intellectual property rights in order to "give away" its end product. Ten years to negotiate through the blocking patents and IPRs in order to develop a downstream agricultural product designed to treat blindness and address food insecurity in the developing world.[249] Even without international patents, it is not hard to see why agricultural biotechnological research focused on the crops staple to the sub-Saharan diet have not advanced so as to treat food insecurity in the region.

The food insecurity situation in sub-Saharan Africa is an emergency with global implications. Crop biotechnology offers a strong treatment for the emergency through innovative applications of patented research tools in agricultural development. Crop biotechnology patents present some barriers to the access of these tools thereby preventing these innovations from taking place.

C. *Limitations on Intellectual Property Rights*

If intellectual property rights and patents block access to the R&D

Projects, AGBIO WORLD (AgBioWorld, Auburn, AL) (April 2004) [hereinafter Potrykus, *Experience*], http://www.agbioworld.org/biotech-info/articles/biotech-art/potrykus.html (last visited Nov. 30, 2005).

244. Ingo Potrykus, *Golden Rice and Beyond,* 125 PLANT PHYSIOLOGY 1157 (2001) [hereinafter Potrykus, *Golden Rice and Beyond*].

245. Potrykus, *Experience*, *supra* note 243.

246. *E.g.*, companies like "Syngenta and other agribiotech industries." *Id.*

247. *Id.*

248. *Id.* (Five years to overcome the research tool IPRs to develop the technology, and an estimated five more years to remove the IPRs to free the product up for donation). The acronym "GMO" stands for "genetically modified organism," such as *GoldenRice*™.

249. *Id. See also* Potrykus, *Golden Rice and Beyond, supra* note 244, at 1157, 1161.

tools needed to treat food insecurity, then IPRs and patents are barriers to the solution and efforts must be taken to address this problem. This sub-section will describe some available limitations on patent rights to technologies which may be used to increase food security research. Because patent rights are so vital to the economy, they are some of the most jealously protected property rights in American law.[250]

1. Research Exemptions to Patent Rights

Patents for agricultural biotechnology are utility patents.[251] There is no practical research exemption available to utility patents.[252] In *Madey v. Duke University*, the U.S. Court of Appeals for the Federal Circuit held that the available research exemption in patent law is "very narrow and strictly limited."[253] The Court rejected the district court's ruling that an affirmative defense existed for use of a patented invention for "research, academic, or experimental . . . [and] non-profit purposes."[254] The Court held the research exemption is limited to uses "for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry" and not for the research conducted at a university.[255]

Commentators have argued the research exemption should be broadened to exempt the non-commercial and experimental uses likely to benefit food insecure developing countries in sub-Saharan Africa.[256]

2. Compulsory Licenses to Use Patented Technology

The phenomenon of compulsory licensing of intellectual property rights is not an unknown legal tool. There are statutory requirements for compulsory licenses for inventions which serve the public interest, such as provisions within the Clean Air Act and the Atomic Energy Act.[257] U.S. copyright law has a compulsory license provision for the

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250. C.L. Clemente, Editorial, *A Prescription for Economic Invigoration and Global Health*, 1 PFIZER J. 1 (2000), http://www.thepfizerjournal.com/pdfs/TPJ13.pdf (last visited Nov. 30, 2005) (arguing that strong patent protection is fundamental to the economy of the United States).

251. ECON RESEARCH SERV., USDA, AGRICULTURAL BIOTECHNOLOGY INTELLECTUAL PROPERTY: TECHNOLOGY CLASSIFICATION, http://www.ers.usda.gov/data/AgBiotechIP/classification.htm (last visited Nov. 30, 2005).

252. Taylor & Cayford, *supra* note 39, at 360.

253. Madey v. Duke Univ., 307 F.3d 1351, 1361 (2002).

254. *Id.* at 1361 (quoting summary judgment opinion from the court below, 266 F.Supp. 2d 420 (2001)).

255. *Id.* at 1362 (quoting Embrex v. Service Engineering Corp., 216 F.3d 1343, 1349 (2000)).

256. Taylor & Cayford, *supra* note 39, at 360.

257. *Id.* at 361.

copying and distribution of "nondramatic musical works" in phonorecords or digital transmission.[258] International treaty law contains provisions which allow for the creation of compulsory licenses to facilitate access to technology for situations such as food security emergencies.[259] However, there are no compulsory license provisions in U.S. patent law.[260] Therefore, agricultural biotechnology firms cannot be obliged to license their technology to help stave the food security problem in sub-Saharan Africa. A global security emergency with food insecurity as one of its root causes may require the use of another source of compulsion to motivate agricultural biotechnological firms to license their patented research tool technologies.

3. *The Power of Eminent Domain*

"Eminent domain is the power of the sovereign to take property for the 'public use' without the owner's consent."[261] In Western civilization, this right of the sovereign originated in the dawn of written history—references to what we know of as the power of eminent domain have been found in the Athenian Constitution of Aristotle and in the Old Testament.[262] It has been recognized that the development of the modern state has depended upon the existence of this legal doctrine which qualifies the absolute right the sovereign traditionally enjoyed over private property.[263] The power of eminent domain has been enshrined (and limited) in the "Takings Clause" of the Fifth Amendment to the U.S. Constitution.[264] The limitations to the power enjoyed by the government are the requirements that takings of private property rights be for "public use" and with "just compensation."[265]

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258. 17 U.S.C. § 115 (2005).

259. *See, e.g.*, TRIPS, *supra* note 212, at § 5, art. 31.

260. Taylor & Cayford, *supra* note 39, at 361.

261. 1 NICHOLS ON EMINENT DOMAIN § 1.11, 1-7 (Julius L. Sackman ed., 3d ed. 2003) (1909) [hereinafter NICHOLS].

262. CARMAN F. RANDOLPH, THE LAW OF EMINENT DOMAIN IN THE UNITED STATES 3 (Fred B. Rothman & Co. 1991) (1894).

263. RICHARD A. EPSTEIN, TAKINGS: PRIVATE PROPERTY AND THE POWER OF EMINENT DOMAIN ch. 2 (1985); *see also* NICHOLS, *supra* note 261, at § 1.11, 1-9.

264. "[N]or shall private property be taken for public use, without just compensation." U.S. CONST. amend. V; *see also* Ned Snow, *The Constitutional Failing of the Anticybersquatting Act,* 41 WILLAMETTE L. REV. 1 (2005) (discussing the Takings Clause in the context of modern technology).

265. NICHOLS, *supra* note 261, at § 1.11, 1-9 & 1-10. "The 'public use' element is set forth in some definitions as the 'general welfare,' the 'welfare of the public,' the 'public good,' the 'public benefit,' or 'public utility or necessity.'" *Id.* The Fifth Amendment may be thought of as an "amplified definition" of Eminent Domain with its inclusion of the "just compensation" element, however, it is in fact a limitation of the power. *Id.* at § 1.11, 1-10;

The property right bestowed by a patent is "the right to exclude others from making, using, selling, offering to sell or importing the claimed invention for a period of twenty years."[266] When this right is infringed, the patent owner may bring a lawsuit to enjoin the infringement and/or sue for damages.[267] The patent right is an intangible property right created by Congress, which is protected by the Takings Clause of the Fifth Amendment.[268] Yet, because of the high value society places on providing incentives for innovation, there have been relatively few instances of governmental takings of patent rights.[269]

IV. A PROPOSAL: TAKING DURING A NATIONAL EMERGENCY

A. Background

28 U.S.C. § 1498 addresses takings of patents where an entity which makes or uses a patented invention under contract to the United States government is shielded from prosecution and all claims for infringement are instead to be directed toward the government for reasonable compensation.[270] This section of the U.S. Code is closely analogous to the Takings Clause of the Fifth Amendment because it provides for "reasonable and entire compensation" for owners whose patent rights have been infringed.[271] To date, the federal government has never used the eminent domain power to appropriate patented technology in the name of an emergency. However, after the September 11, 2001 attacks, such action was seriously contemplated by the U.S. government.

Two weeks after the September 11th attacks, the prospect of a

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see also Michael Treanor, *The Origins and Original Significance of the Just Compensation Clause of the Fifth Amendment*, 94 YALE L. J. 694, 713-14 (1985).

266. Daniel R. Cahoy, *Treating the Legal Side Effects of Cipro: A Reevaluation of Compensation Rules for Government Takings of Patent Rights,* 40 AM. BUS. L.J. 125, 129-31 (2002).

267. *Id.* There are two categories for one who infringes a patent: "A direct infringer is anyone who 'without authority makes, uses, offers to sell or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent.'" *Id.* at n.21 (quoting 35 U.S.C. § 271(a) (2005)). "One can also indirectly infringe a patent by inducing another to infringe or contributing to another's infringement." *Id.* (citing 35 U.S.C. § 271(b) and (c) (2005)).

268. *Id.* at 132-34.

269. *Id.* at 125, 175.

270. 28 U.S.C. § 1498(a) (2005).

271. *Id.* The courts have largely construed § 1498 as the remedy for patent owners whose rights have been taken by eminent domain. *See, e.g.*, Decca Ltd. V. United States, 640 F.2d 1156, 1166 (Ct. Cl. 1980), *cert. denied* 454 U.S. 819 (1981).

biological attack involving *Bacillus anthracis* ("anthrax")[272] prompted people to stockpile the only known antidote, ciprofloxacin, or Cipro®, a product patented and branded by the German pharmaceutical giant, Bayer.[273] Three weeks after September 11th, with anthrax attacks no longer a prospect but a fact, and supplies of Cipro® limited by Bayer's patent, Canada overrode the patent and ordered Bayer's competitors to produce the needed antidote in the form of generic ciprofloxacin.[274] For a period of time, many called upon the U.S. government to take the same action and order enough doses of the antidote to prevent a national emergency.[275] After a month of uncertainty, Bayer eventually agreed to produce the needed doses at a reasonable price, thereby preventing the threatened taking.[276]

The anthrax attacks introduced the question of whether the U.S. government should have initiated a taking by, in effect, granting compulsory licenses to manufacturers of generic ciprofloxacin to infringe upon Bayer's patent rights to Cipro®. It is the conclusion of this Note that such an action during a national emergency would have indeed been proper. Likewise, if serious global insecurity caused by severe food insecurity were to cause an emergency of similar proportions, it would be proper for the U.S. government to use 28 U.S.C. § 1498 to allow the use of patented agricultural biotechnological research tools in the research and development of improved varieties of the crops staple to the sub-Saharan African diet.

Critics of this conclusion point to the need for inviolable patent rights to protect the incentives for invention and innovation.[277] In addition to the above discussion, this Note further concludes, as will be discussed below, that such an incentive will not be unduly weakened by a limited use of the power of eminent domain in times of national emergency. What is at issue, then, is the tension between the incentive to develop new technology and access to that technology to treat a

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272. *See* Robert Shapiro, *Patent Infringement During a Time of National Emergency: Are Canadian, American and Mexican Governments Permitted to Do So under Their Domestic Law, Nafta and Trips; If So at What Cost?*, 18 WINDSOR REV. L. & SOC. ISSUES 37, 39 (2004).

273. Tamar Levin, *A Nation Challenged: Fear of Infections; Anthrax Scare Prompts Run on Antibiotic*, N.Y. TIMES, Sept. 27, 2001, at B8.

274. Amy Harmon & Robert Pear, *A Nation Challenged: The Treatment; Canada Overrides Patent for Cipro to Treat Anthrax*, N.Y. TIMES, Oct. 19, 2001, at A1.

275. Donald G. McNeil, *A Rush for Cipro, and the Global Ripples*, N.Y. TIMES, Oct. 17, 2001, at A1.

276. Keith Bradsher, *Bayer Agrees to Charge Government a Lower Price for Anthrax Medicine*, N.Y. TIMES, Oct. 25, 2001, at B8.

277. *See* Cahoy, *supra* note 266, at 171-75.

national emergency.

B. When Emergencies Change the Debate: Incentive vs. Access to Technology

At its root, the fundamental issue with intellectual property rights often is whether the public interest in the incentive for invention outweighs the public interest in access to patented technology thus generating continued innovation.[278]

1. The Incentive to Invent

For members in the incentive camp, the long-term costs in diminished incentives outweigh any short-term benefits in treating an emergency.[279] This is because without the incentive to invest in time and capital, inventors will not invest in vital technologies like biotechnology.[280] What is more, it has been observed that were the government to order patent infringement, say, during an Anthrax emergency, the costs of its "just compensation" obligations would have been prohibitively high.[281]

In order to illustrate this prohibitive cost to the government in using its powers of eminent domain, Professor Daniel Cahoy, in his 2002 article in the *American Business Law Journal*, substituted patent property for real property in an analysis of "just compensation" originated by Judge Richard Posner:

> Let us assume that the wholesale cost in the United States of treating an individual with a certain anti-anthrax antibiotic is $ 200 per month (prices for illustration purposes only). Next, assume that there are 10,000 people who could possibly benefit from treatment with the antibiotic, but for a cost of $ 1 million (screening, investigating, etc.), the government could make a much more accurate determination of the affected number of people and cut the number of treated individuals to 1,000. If the government must pay the market price for the antibiotic, the cost to both the government and society as a whole—which includes the patent owner—under the cheaper screening option will be $ 1.2 million ($ 1 million screening + $ 200 x 1000 people). Alternatively, if the government can appropriate the

278. Katie Sykes, *Patents and the Public Interest: The Cipro Controversy*, 60 U. TORONTO FAC. L. REV. 115 (2002).

279. *See* Cahoy, *supra* note 266, at 169-71.

280. *Id.* at 171.

281. *Id.* at 174.

anti-anthrax antibiotic and pay only the generic cost (assume it is 10 cents on the dollar), the total cost to the government if it chooses to forego the screening option will be $ 200,000 ($ 20 x 10,000 people), but the cost to society as a whole is $ 2 million ($ 200 x 10,000 people). Obviously, this example oversimplifies many issues, but it is useful in creating a common framework.[282]

2. *An Overlooked Incentive: Emergencies*

A most crucial word missing in Professor Cahoy's scenario—a word which appears to have missed its mark for the incentive camp entirely—is "Emergency." During the Anthrax attacks, the question was not simply whether Bayer would be motivated to continue its research and develop new medicines, but whether its patent would block access to the antidote needed to save the lives of, potentially, tens of millions of people in America. Similar questions have been raised by the need for other antidotes, for example whether there is enough potassium iodide available for an emergency arising out of a terrorist attack on a nuclear facility.[283]

What is more, the question of patents blocking needed technology is not limited to emergencies which arise from terrorist attacks. At its 115th Executive Board and Health Assembly meeting, the World Health Organization included discussions of Avian Influenza, or "Bird Flu," in its agenda.[284] The assembled members expressed the concern "about the general lack of preparedness for an influenza pandemic."[285] Intellectual property rights, patents on the needed treatments for Avian Influenza in particular, were identified as one of the specific problems in meeting this potential emergency.[286] Still, it is the destabilizing effects emergencies have on society which introduce the gravest security risks.

The United States pursues its freedom from fear in several ways, not least of which is through its powerful military. The U.S. will spend

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282. Cahoy, *supra* note 266, at n.194 (using an analysis *from* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 58 (4th ed. 1992).

283. *Antiradiation Pills are Urged for Children*, N.Y. TIMES, Apr. 8, 2003, at A18; *see also* Ian Urbina, *City Weighs Plans to Deliver Medicine to Public After Attack*, N.Y. TIMES, Feb. 7, 2005, at B1.

284. *Influenza Pandemic Preparedness and Response*, World Health Organization (WHO) Executive Board and Health Assembly, 115th Sess., Agenda Item 4.17, WHO Doc. EB115/44 (2005), http://www.who.int/gb/e (follow "EB115" hyperlink; then "EB115/44" hyperlink) (last visited Nov. 30, 2005).

285. *Id.* at ¶ 1.

286. *Id.* at ¶ 20.

more than $500 billion on the military in 2005, "[b]ut that amount is never going to buy Americans peace if the government continues to spend an anemic $16 billion . . . in foreign aid that addresses plight of the poorest of the world's poor."[287] On December 26, 2004, a large earthquake off of the Indonesian coast created a tsunami which claimed over 100,000 lives, which destabilized many areas of Asia and Africa and created a great emergency for those regions.[288] The developed world rose to the occasion and has organized multiple ways of helping the tsunami victims, while keeping an eye on the needs of the rest of the developing world.[289]

It has been noted that 30,000 children die from poverty related deaths every single day.[290] Therefore, every five days, another virtual tsunami sweeps the world. As has been discussed above, agricultural biotechnology can help.

3. *Actually, Access Is the Incentive*

The argument for preserving the property rights incentive in intellectual property is compelling. This Note does not seek to deny that our intellectual property laws are a vital part of the forward moving society we enjoy. Why would a firm invest huge sums of capital and develop a product if the government will simply take it and give it away? Again, the crucial word in this discussion is "Emergency"—it is unlikely that the power of eminent domain will be used haphazardly in the appropriation of patented technology because even during the Anthrax attacks (a national emergency) such an event did not take place.

Professor Cahoy used the Cipro®/Bayer controversy for what he identified as a "real world" prediction of the just compensation that the United States would have to pay the infringed patent holder.[291] As already noted, Professor Cahoy would find the costs of such action prohibitive; and these costs could not outweigh the interest in incentives

287. *Thousands Died, supra* note 108.

288. Ian Fisher, *In Stench, mid Ghosts, Seeking the Tsunami Dead*, N.Y. TIMES, Jan. 21, 2005, at A1.

289. Elisabeth Bumiller & Elizabeth Becker, *Asia's Deadly Waves: The President; As U.S. Aids Tsumani Victims, Bush Urges Donors Not to 'Shortchange' Other Parts of the World*, N.Y. TIMES, Jan. 11, 2005, at A10.

290. MILLENNIUM CAMPAIGN, *supra* note 48, at Goal 1: Eradicate Extreme Poverty and Hunger. *See also Thousands Died*, *supra* note 108. "More than 20,000 people perished yesterday of extreme poverty." *Id.* (noting that "yesterday" is in relation to every single day).

291. Cahoy, *supra* note 266, at 171, 173.

for invention.[292] However, this analysis does not stand up to reality because the more likely result is the one which *really did occur*, specifically, an agreement between Bayer and the U.S. government which precluded any action under the power of eminent domain.[293] The government wanted access to the technology that Bayer held. When the threat of a taking seemed real, Bayer found incentive to meet the needs of the nation in a time of emergency.

Incentives for invention come in profits. Bayer is reported to earn $1 billion per year on Cipro®.[294] It is reasonable to infer that such profits inspired Bayer to recognize the value of agreeing to lower its prices and to increase its output to meet the short-term *emergency* demand for Cipro® made by the government in October 2001. It is also reasonable to infer that there is incentive from such profits to continue the R&D which leads to them—even though such a demand and an emergency compromise may actually introduce itself. Agricultural biotechnological firms, for example Monsanto, are some of the most profitable companies in the world.[295] It is just as reasonable to infer that Monsanto's interest in preempting the government's use of its eminent domain power in time of a recognized emergency outweighs an inference that Monsanto will cease the R&D of new technologies and products.

If the United States made it clear to the biotechnological and chemical firms in the pharmaceutical and agricultural research and development industries that a policy centered around the power of eminent domain is on the table to treat international and national emergencies, they will not likely be motivated to cease operations, but will merely plan to avoid such a reality.[296] Thus, access to patented technology through the power of eminent domain, creating compulsory

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292. *See* discussion *supra* Part IV.B.1.

293. Keith Bradsher, *A Nation Challenged: The Cost; Bayer Agrees to Charge Government a Lower Price for Anthrax*, N.Y. TIMES, Oct. 25, 2001, at B8 (emphasis supplied). I do not question Professor Cahoy's analysis of the government's hypothetical "Just Compensation"; his work, no doubt, established a most accurate conclusion. I do, however, observe that the "real world" is what actually happened, and therefore find the power of eminent domain most effective in meeting a national emergency, whether it is ultimately utilized or not.

294. Margaret Cronin Fisk, *Bayer Accused of Illegal Deal to Suppress Generic Versions of Cipro*, FULTON COUNTY DAILY REPORT, Oct. 25, 2001, available at LexisNexis.

295. *See* Serageldin, *supra* note 25.

296. Paul Janicke, *Current State of U.S. Patent Law Regarding Infringement of Drug Patents by the Government*, University of Houston Law Center, http://www.law.uh.edu/healthlaw/perspectives/Food/011207Current.html (last visited Nov. 30, 2005).

licenses, under situations of serious emergency, will act as an incentive itself. The power of eminent domain can assist and treat the problem of food insecurity, and at the same time will not hinder our society from moving forward.

CONCLUSION

The power of the eminent domain should be used to improve access to agricultural biotechnological research tools. The balance of access to technology in times of emergency outweighs the public interest in maintaining the incentives for invention and innovation because of the multitude of human lives that are potentially at stake.

What is more, the actual incentive to preempt any moves made by the U.S. government in this regard, as was the case for Bayer with Cipro®, will likely obviate any need for such patent appropriations. By announcing a clear policy embodying the power of eminent domain to utilize patented biotechnological research tool technology in times of emergency, the United States could raise the awareness of the severity of the global problem of chronic hunger caused by severe food insecurity. A problem where more than 800 million people are chronically hungry, 1.2 billion live on less than a dollar a day, and more than 30,000 children die every single day.[297]

There is a potential for a global security catastrophe and treating food insecurity through improvements in agricultural productivity is one sure way to keep Malthusian prophecies at rest. Therefore, the power of eminent domain is an efficient way to treat a food security emergency and ensure that "all people, at all times, have physical and economic access to sufficient, safe and nutritious food," for the continued security of us all.[298]

297. MILLENNIUM CAMPAIGN, *supra* note 48, at Goal 1: Eradicate Extreme Poverty and Hunger.

298. WORLD FOOD SUMMIT, *supra* note 1.