

# Implications of Genetically Modified Crops and Intellectual Property Rights on Agriculture in Developing Countries

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## Abstract

Food is essential for human survival. When the right quantity and quality is taken, it ensures growth and an adequate supply of nutrition to the body, which results in basic effectiveness in all spheres of life. Genetically modified crops have the potential to alleviate hunger and provide more food, especially in developing countries that have high levels of hunger, malnutrition and poverty. Although the debates on genetically modified crops generally focus on intellectual property, other issues include health and environmental concerns. This article examines these issues with the aim of providing holistic knowledge of the subject matter, which is important for stakeholders, particularly in developing countries, in deciding to protect plant variety rights. The article concludes that it is essential for developing countries to consider food security issues in fulfilling their obligations under the TRIPS Agreement.

## Keywords

Genetically modified crops, intellectual property rights, agriculture, developing countries, food security

## INTRODUCTION

Hunger constitutes a violation of people's human rights<sup>1</sup> and is capable of hindering development, reducing productivity and increasing the rate of conflict

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1 See the Universal Declaration on the Eradication of Hunger and Malnutrition of 1974; International Covenant on Economic, Social and Cultural Rights 1966, art 11; International Covenant on Civil and Political Rights 1966, General Comment No 6 on art 6; Declaration on the Rights of Disabled Persons of 1975; Convention on the

and crime in societies. The World Food Summit, convened in Rome in 1996 by the Food and Agriculture Organization of the United Nations (FAO), reported that more than 800 million people, mainly in developing countries, do not have enough food to meet their basic nutritional needs.<sup>2</sup> This has several effects on various sectors of these developing countries and threatens the future of individuals. According to former US President Jimmy Carter, “[t]here can be no peace until people have enough to eat”.<sup>3</sup> It is not possible for people to live in poverty and starvation and then to be expected to contribute positively to the development of their country.<sup>4</sup> Agriculture has a huge role to play in eradicating hunger and promoting food security, as most poor people who live in rural areas depend on it for their source of both income and food. Agriculture is also the strength of the economy in most developing countries and accounts for a large share of gross domestic product while supplying a large proportion of basic foods.<sup>5</sup> Apart from its importance in producing sufficient food, it also enhances job creation and employment.<sup>6</sup>

Thus, to improve agricultural output, enable agriculture to be more lucrative and provide people’s basic needs in terms of food and nutritional value,<sup>7</sup> biotechnology has been introduced to create hybrid plants that would not have been possible naturally. One form of biotechnology is genetic engineering, which involves copying a gene from one living organism and adding it to another organism in order to alter and reprogram its genetic makeup. Such modified products are referred to as genetically modified organisms (GMOs).<sup>8</sup> Genetically modified (GM) crops constitute the majority of GMOs that have been introduced into the environment; they are very important because they increase food security and combat malnutrition and poverty by creating specialty crops with high productivity, better nutritional value and enhanced resistance to disease.<sup>9</sup> Furthermore, they have direct and indirect ecological, economic and social consequences in countries

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Elimination of all Forms of Discrimination against Women of 1979; and Declaration on the Right to Development of 1986, which provides for a right to adequate food. See also M Blakeney *Intellectual Property Rights and Food Security* (2009, Cab International) at 1 and 8.

2 Blakeney, *ibid.*

3 C Gordan “Genetically modified crops: Risks and promise” (2000) 4/1 *Conservation Ecology* 1 at 2.

4 *Ibid.*

5 Blakeney *Intellectual Property Rights*, above at note 1.

6 WP Falcon “Sustainable science for a sustainable environment: Comments on searching for sustainability” (2001) 27/1 *Ecology Law Quarterly* 1163 at 1164.

7 Gordan “Genetically modified crops”, above at note 3.

8 AM Shelton “Risks and benefits of agricultural biotechnology” in FE Ahmed (ed) *Testing of Genetically Modified Organisms in Food* (2004, Food Products Press) 1 at 1 and 2.

9 GC Catacora-Vargas *Genetically Modified Organisms: A Summary of Potential Adverse Effects Relevant to Sustainable Development* (Genok Biosafety Report, 2011, Centre for Biosafety) at 7; RW Herdt “Assisting developing countries towards food self-reliance”, available at: <<http://www.pnas.org/content/95/5/1989.full>> (last accessed 20 March 2017).

that have adopted them.<sup>10</sup> GM crops are especially important to developing countries, such as Nigeria where the government has recently realized that the economy can no longer depend heavily on oil.<sup>11</sup>

Initially, genetic engineering of crops with multiple genes was difficult and only succeeded in cases where the desired traits were determined by only one or few genes.<sup>12</sup> However, advances have been made in genetic engineering as multiple genes can now be inserted so as to combine the traits added by each gene, which is referred to as stacking.<sup>13</sup> For example the Rockefeller Foundation, a global foundation with a mandate to enrich and sustain the lives of the poor, has been able to pyramid two or more genes with the effect of increasing resistance to pathogens. Several component traits have also been added together to produce rice plants that are resistant to drought.<sup>14</sup>

The main GM crops for agricultural and industrial processes are maize, soybean, cotton and rapeseed. GM crops are grown in varying amounts in many countries, the largest producers being the United States (US), Canada, Brazil, Argentina and India, with a gradual shift towards developing countries.<sup>15</sup> A survey dealing with GM crops, conducted by Cohen<sup>16</sup> at 61 public research institutes in 15 developing economies,<sup>17</sup> discovered that the institutes in question have the capacity to transform genetic resources across 45 plants, within eight categories of different transgenic phenotypes. However, the report noted that it is still difficult for countries in sub-Saharan Africa, with the exception of South Africa, to make such advances due to a lack of competence and resources to undertake advanced research of such a nature. Thus, many countries are still considering whether to conduct research on GM crops or products. Research capacity and potential markets are however evolving, such as in the search for insect resistant cotton.<sup>18</sup> Another reason why GM crops have not gained worldwide acceptance is because stakeholders are concerned about the long term effects they might have on health, the environment and

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10 Catacora-Vargas *Genetically Modified Organisms*, above at note 9.

11 Oil currently serves as a main source of income in Nigeria. Increasing agricultural output would supplement the income from oil and also reduce the effect that pollution has on the environment from gas flaring and oil bunkering. Poverty levels will also reduce if people have sufficient food to eat at low cost.

12 JP Oczek "In the aftermath of the 'terminator' technology controversy: Intellectual property protections for genetically engineered seeds and the rights to save and replant seed" (2000) 41/1 *Boston College Law Review* 627 at 635.

13 GC Nelson "Traits and techniques of GMOs" in GC Nelson (ed) *Genetically Modified Organisms in Agriculture: Economics and Politics* (2001, Academic Press) 7 at 8.

14 Gordan "Genetically modified crops", above at note 3.

15 Catacora-Vargas *Genetically Modified Organisms*, above at note 9.

16 JI Cohen "Poorer nations turn to publicly developed GM crops" (2005) 23/1 *Nature Biotechnology* 27 at 32.

17 Egypt, Kenya, South Africa, Zimbabwe, Argentina, Brazil, Costa Rica, Mexico, China, India, Indonesia, Malaysia, Pakistan, Philippines and Thailand.

18 Cohen "Poorer nations", above at note 16.

other aspects of society.<sup>19</sup> Legal issues, in particular regarding intellectual property rights (IPRs), have also been raised.

This article aims to discuss the meaning of GMOs, as well as the benefits and disadvantages involved in modifying crops genetically. It analyses the meaning and purpose of IPRs and their relevance to GMOs. The question of whether IPRs can be claimed in respect of organisms that have been modified genetically thus comes into play. Furthermore, the article analyses the legal significance of IPRs in respect of GMOs and offers recommendations.

## MEANING, BENEFITS AND DISADVANTAGES OF GENETICALLY MODIFIED ORGANISMS

A GMO is an organism, that is a plant, animal or microorganism, “whose genetic material has been altered using gene or cell techniques of modern biotechnology”.<sup>20</sup> A plant’s genetic material is modified through the manipulation of its deoxyribonucleic acid (DNA) by the removal of genes from that organism into the DNA of another, resulting in the production of GM seeds with properties of the new genetic material.<sup>21</sup> Such genetic information cannot be transferred naturally across species through conventional breeding.<sup>22</sup> Thus, “GM crops are plants engineered by scientists who have inserted pieces or strands of foreign genetic material in an effort to change or supplement one or more of the plant’s traits”.<sup>23</sup> According to Millis, the first GMO was made in 1972 and a GM crop was produced ten years later.<sup>24</sup> By 2004, eight million farmers in 17 countries had grown 81 million hectares of modified soya bean, cotton, canola and maize.<sup>25</sup> Genes that confer herbicide resistance and insect tolerance are the most widely used commercially.<sup>26</sup> According to the International Service for the Acquisition of Agri-biotech Applications,

19 FE Ahmed “Detection of genetically modified organisms in food” (2002) 20/5 *Trends in Biotechnology* 215 at 215.

20 International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD) *Agriculture at a Crossroads* (global report, 2009, Island Press) at 590. See also Shelton “Risks and benefits”, above at note 8.

21 K Kariyawasam “Legal liability, intellectual property and genetically modified crops: Their impact on world agriculture” (2010) 19/3 *Pacific Rim Law & Policy Journal* 459 at 459 and 460.

22 A Cockburn “Assuring the safety of genetically modified (GM) foods: The importance of an holistic, integrative approach” (2002) 98 *Biotech Journal* 79 at 79 and 80.

23 R Ahmed and NJ Shaba “GM crops introduced in agriculture: A critical appraisal in determining legal liability & effective measures preventing GM contamination” (2015) 20/12 *IOSR Journal of Humanities and Social Science* 38 at 38.

24 N Millis “Genetically modified organisms” (2006), available at: <<http://www.environment.gov.au/system/files/pages/c4e4d913-0e4d-46f0-a41d-940a34885c7b/files/gmo.pdf>> (last accessed 31 March 2017).

25 Ibid.

26 Ibid.

114,000,000 hectares (281,000,000 million acres) of GM crops were cultivated in 2007, in 23 countries.<sup>27</sup>

GM crops can be helpful in feeding the world as they result in more productive harvests.<sup>28</sup> This has the overall effect of a huge supply of agricultural products to meet high demand, automatically leading to low prices.<sup>29</sup> GM crops also improve the wellbeing of millions of people in developing countries who are malnourished and of children who are underweight and suffering from iron deficiency, which reduces infant and maternal mortality.<sup>30</sup> To feed the global population, which has been predicted to increase to more than nine billion by 2050,<sup>31</sup> the United Nations states that agricultural output will have to rise 50 per cent by 2030, requiring a revolution in world agriculture, especially in developing countries.<sup>32</sup> GM crops will be required in this respect. According to Dr Jacques Diouf, FAO director-general, “GMOs can help to increase the supply, diversity and quality of food products and reduce costs of production and environmental degradation, as the world still grapples with the scourge of hunger and malnutrition”.<sup>33</sup>

Furthermore, GM crops improve the state of the environment through a reduction in the use of chemical inputs and dangerous pesticides.<sup>34</sup> For example, plants that have been modified to produce toxins poisonous to caterpillar larvae reduce the number of chemicals sprayed on such plants, which protects useful insects and also reduces the rate at which soil and waterways are polluted by chemicals.<sup>35</sup> Soil quality also improves, as herbicide resistant crops have less need for weed control. This in turn leads to fewer tractors on fields and, thus, reduced soil erosion.<sup>36</sup> Other GM crops serve the purpose of developing new foods or ripening delayed crops such as tomatoes.<sup>37</sup>

27 S Lawrence “Brazil surpasses US in new transgenic crop plants” (2008) 26 *Nature Biotech* 260 at 260. See also Kariyawasam “Legal liability”, above at note 21.

28 H Souza “Genetically modified plants: A need for international regulation” (2000) 6/1 *Annual Survey of International and Comparative Law* 129 at 138.

29 T Ilori “The challenges of genetically modified organisms (GMO) in Nigeria”, available at: <<http://abusidiqu.com/challenges-genetically-modified-organisms-gmo-nigeria-tomiwailori/>> (last accessed 20 March 2017).

30 Gordan “Genetically modified crops”, above at note 3.

31 M Kallmann “Genetically modified crops and the future of world agriculture”, available at: <<https://www.globalpolicy.org/component/content/article/220/47331.html>> (last accessed 20 March 2017).

32 Kariyawasam “Legal liability”, above at note 21 at 461.

33 FAO “FAO director-general stresses benefits of biotechnology in fighting hunger and malnutrition and calls for open debate on potential risks” (press release, 14 May 2001), available at: <[http://www.fao.org/WAICENT/OIS/PRESS\\_NE/PRESSENG/2001/pren0131.htm](http://www.fao.org/WAICENT/OIS/PRESS_NE/PRESSENG/2001/pren0131.htm)> (last accessed 20 March 2017).

34 GC Nelson “Introduction” in GC Nelson (ed) *Genetically Modified Organisms in Agriculture: Economics and Politics* (2001, Academic Press) 3 at 5.

35 Millis “Genetically modified organisms”, above at note 24.

36 GC Nelson and A de Pinto “GMO adoption and nonmarket effects” in Nelson (ed) *Genetically Modified Organisms*, above at note 34, 21 at 60.

37 Nelson “Introduction”, above at note 34 at 7.

Despite the benefits of GMOs for the environment, they have some considerable risks, which have been expressed by various individuals and organizations. People are mostly concerned about the potential health and environmental effects.<sup>38</sup> These concerns are compounded by the fact that some effects of GM crops are still unknown and have an air of uncertainty wrapped around them. In respect of others, the impact of GM crops is still under development and completed impact assessments have been limited to few areas.<sup>39</sup> There could also be risks to the environment, as it has been stated that there is a possibility that new genes added to GM crops might escape to nearby weeds or other plants, which makes weed control difficult to handle and negatively affects the environment.<sup>40</sup> Developing countries could experience more risks because there is a higher prevalence of cultivated land mixed with uncultivated land. Furthermore, viral genes added to a plant to confer resistance could also lead to the creation of new viruses.<sup>41</sup> GM crops could also affect farmers in developing countries as they could be forced to rely on multinationals for their future livelihoods as opposed to them participating in the food system not only as consumers, but also as producers and innovators. That way, they can reap some of the benefits of innovation and production to sustain their economic growth.<sup>42</sup>

## MEANING OF INTELLECTUAL PROPERTY AND RATIONALE FOR PROTECTING INTELLECTUAL PROPERTY

Intellectual property (IP) generally refers to proprietary rights granted over products of the human mind. Defining IP in this sense could however mean that all products of the human mind (a wide definition) would be classified as IP. This is however not the case, as IPRs are intangible rights protecting commercially valuable products of the human intellect.<sup>43</sup> IP laws therefore create exclusive rights for the creator or author in his intellectual creation as opposed to the physical property or object embodying that intellectual

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38 ND Hamilton "Legal issues shaping society's acceptance of biotechnology and genetically modified organisms" (2001) 6/1 *Drake Journal of Agricultural Law* 81 at 83.

39 The importance of risk assessment is reflected in arts 15, 16 and 22 of the Cartagena Protocol on Biosafety, 2000, which recognizes the need to increase scientific capacity in risk assessment and risk management methods. Steps towards achieving this include hazard identification, exposure and effects assessment, and risk communication. See KR Hayes et al "Environmental risk assessment for transgenic fish" in AR Kapuscinski, KR Hayes, S Li and G Dana (eds) *Environmental Risk Assessment of Genetically Modified Organisms: Methodologies For Transgenic Fish* (2007, Biddles Press) 1 at 4 and 14; IAASTD *Agriculture at a Crossroads*, above at note 20 at 94.

40 For example, plants such as canola have a high risk of outcrossing within species; this could be controlled by ensuring that the pollen of the GMO is sterile. See Nelson and de Pinto "GMO adoption", above at note 36.

41 Gordan "Genetically modified crops", above at note 3.

42 Ibid.

43 BA Garner (ed) *Black's Law Dictionary* (8th ed, 1999, West) at 824.

creation.<sup>44</sup> For instance, the IP in a book usually belongs to the author while the ownership of the physical property embodying the knowledge lies with the buyer of the book. In the broad sense therefore, IPRs refer to legal rights that result from intellectual activity in the industrial, scientific, literary and artistic fields.<sup>45</sup>

Certain types of IPRs are widely recognized. These are patents, trademarks, copyright, geographical indications and plant variety rights. Other ways in which IP can be protected include trade secrets or confidential information and unfair competition. Products of human creativity and invention can be seen all around us, for example as cars, computers, the internet, and popular trademarks such as Coca Cola, Nescafé, Nestlé and Globacom. Plant engineering and GMOs are also a product of human creativity and innovation and are therefore protected by IPRs. Since IP is of utmost importance to human society, governments protect it for various reasons.<sup>46</sup> One is to give statutory expression to creators' moral and economic rights and the public's right to access these creations. IPRs also promote creativity and the dissemination and application of man's intellect. Such rights encourage fair trading and contribute to society's economic and social development.

In addition, certain theories have been advanced as the rationale for the protection of IPRs.<sup>47</sup> The Natural Law theory posits that everyone has a property right over his original work, creation or inventions. The proponents of this theory believe that, if society can recognize a person's right to his tangible property, it must also recognize his right to the product of his intellect, mind or brain.<sup>48</sup> Therefore everyone has a property right over his ideas or creations, which others in society must recognize and respect. According to Sterne, "[t]he sweat of a man's brow and the exudations of a man's brain are as much a man's own property as the breeches of his backside. Thus, if a person produces something, then, the product of his skill and labour ought to belong to him or the person who commissions him".<sup>49</sup>

Fox argues in support of this theory that the law does not grant an inventor a right to his invention, it only recognizes an original inherent and pre-

44 G Tritton *Intellectual Property in Europe* (3rd ed, 2008, Sweet & Maxwell) at 7. See also World Intellectual Property Organization (WIPO) "Intellectual property handbook: Policy, law and use" (2008), available at: <[http://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\\_pub\\_489.pdf](http://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)> (last accessed 20 March 2017), explaining (at 3) that IPRs "do not apply to the physical object in which the creation may be embodied but instead to the intellectual creation as such".

45 WIPO, *ibid.*

46 *Ibid.*

47 See generally A Adewopo *Nigerian Copyright System: Principles and Perspective* (2012, Odade Publishers) at 151–55.

48 OA Osunbor "What is intellectual property?" (paper presented at the Workshop on Ideas, Inventions, Manufacturing, Finance and Intellectual Property Law, Lagos, 2–5 December 1991) at 5.

49 L Sterne *Tristram Shandy* (Everyman ed, 1912, JM Dent and Sons), quoted in D Guobodia "Fair dealing and copyright in Nigeria" (1989) 2/4 *Business and Property Law Journal* 35 at 40.

existing right, since what a man earns by thought, study and care is as much his own as what he earns by his hands.<sup>50</sup> He puts it succinctly: “[t]he patentee receives nothing from the law which he did not have before. The only effect of the patent is to restrain others from encroaching upon the private property of the patentee - property which is his by the highest possible title of natural right”.<sup>51</sup>

The Universal Declaration of Human Rights supports this theory by providing that “everyone has a right to protection of the moral and material interest resulting from any scientific, literary or artistic production of which he is the author”.<sup>52</sup> According to the Reward theory, having expended time, effort, resources and intellect on a creation or product, its creator, author, inventor or designer should be allowed to reap from his labour. On the basis of ethico-legal considerations, justice therefore demands that the inventor or creator be rewarded for the intellectual labour performed and energy expended for the benefit of society in a manner commensurate with the proportion of welfare generated.<sup>53</sup> Justice demands that he should be able to recover his costs and all other resources expended in the production of the work, and also be rewarded for his labour. The proper means of objectively measuring the required reward is by granting a temporary monopoly over the IP according to the proponents of this theory.<sup>54</sup> The Bible also supports this theory where it states that “you shall not muzzle an ox when it is treading out the grain, and again, the labourer is worthy of his hire”.<sup>55</sup> The US court in *Mazer v Stein* also elucidated on this rationale for protecting IPRs when it held that, “[t]he economic philosophy behind the clause empowering the Congress to grant patent and copyright is the conviction that encouragement of the individual effort by personal gain is the best way to advance public welfare through the talents of author and investors in science and useful arts. Sacrificial days devoted to such creative activities deserve rewards commensurate with the service rendered”.<sup>56</sup>

The Incentive theory, which is similar to the Reward theory, argues that IP enhances the social, cultural, economic and scientific development of society. It is therefore essential for society to protect the rights of inventors and creators as an incentive to encourage them to create and invent more for the benefit of society.<sup>57</sup> The monopolistic right granted by IP laws over the product of a creative activity operates as an incentive for further interest by the creator.<sup>58</sup>

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50 HG Fox *Monopolies and Patents* (1947, The University of Toronto Press) at 201.

51 *Id* at 203.

52 Universal Declaration of Human Rights, art 27(2).

53 U Anderfelt *International Patent Legislation and Developing Countries* (1971, Martinus Nijhoff) at 41.

54 Adewopo *Nigerian Copyright System*, above at note 47.

55 The Holy Bible, Amplified version, 1 Timothy 5:18.

56 [1954] 347 US 201 at 219.

57 Adewopo *Nigerian Copyright System*, above at note 47.

58 *Id* at 154.



The Economic theory posits that IP has a multiplier effect on the economy. The financial and developmental rewards of IP accrue not only to the inventor or author but also to all persons having an associated business and, in the long run, society itself. IP protection brings development and advancement in all ramifications. IP is therefore seen as a veritable tool for development and as being capable of transforming a country.

Finally, the Disclosure theory posits that disclosure of a creative invention or work, which is a prerequisite for registration or the grant of some IPRs including patents, is beneficial to society at large.<sup>59</sup> Disclosure provides society with information about the invention in return for the grant of monopoly rights to the inventor for a fixed period of time. After the expiry of this fixed period, the information is available to the public to use freely and build upon. It should be noted that these theories are not entirely independent of each other as they dovetail into one another.<sup>60</sup> There are also antagonistic arguments against each of these theories. These are however beyond the scope of this work.

## LEGAL ISSUES ARISING FROM GMOs AND IP

Since IPRs confer a monopoly on the owners of a right, things that existed in nature, whether plants or animals including man, were not regarded as the product of man's efforts so as to necessitate IP protection. For ethical reasons, patents and IPRs were generally not allowed on life forms, since this would be likely to create monopolies over matters of health and food, which are basic human needs.<sup>61</sup> Also, unlike manufactured products, biological materials are considered to exist in nature and any alleged "invention" in this regard was seen as a discovery not an invention. This has however changed with hybridization and biotechnology, as well as the emergence of the World Trade Organization's (WTO) Agreement on the Trade Related Aspects of Intellectual Property Rights (TRIPS).

The US, which is known for its interests in enforcing IP rights, wanted other countries to recognize, protect and enforce IP rights. This may be because the US is a technology based country that makes the most of IP rights in boosting its economy and technological advancements. The US was therefore one of the key advocates for including IP matters in the WTO's General Agreement on Trade and Tariffs (GATT).<sup>62</sup> Before 1994, IP matters were the exclusive preserve of the World Intellectual Property Organization. Despite resistance from some developing countries such as Brazil, the US succeeded in its desires for the

59 Osunbor "What is intellectual property?", above at note 48.

60 Adewopo *Nigerian Copyright System*, above at note 47.

61 D Kuyek "Intellectual property rights: Ultimate control of agricultural R&D in Asia" (2001), available at: <<https://www.grain.org/article/entries/30-intellectual-property-rights-ultimate-control-of-agricultural-r-d-in-asia>> (last accessed 20 March 2017).

62 H Stein "Intellectual property and genetically modified seeds: The United States, trade and the developing world" (2005) 3/2 *Journal of Technology and Intellectual Property* 160 at 169.

inclusion of IP protection at the GATT Uruguay round of multilateral trade negotiations in 1994. TRIPS was therefore enacted as annex 1C of the Marrakesh Agreement establishing the WTO, which was signed in Marrakesh, Morocco on 15 April 1994 and took effect in 1995.<sup>63</sup> Hence, every WTO member state is required to comply with TRIPS, which sets minimum standards for IP protection.

Although traditional plant breeders arrived at new plant varieties through hybridization over a long period of time and their plant variety rights were recognized, this recognition of protection over asexual means of plant production through propagation or grafting was all that was initially acceptable under the US Plant Patent Act.<sup>64</sup> However, by the 1950s, protection was also granted to sexual means of plant production through seeds.<sup>65</sup> With the advent of technology and the subsequent emergence of private seed companies, extensive research and development was done to improve plant yields and traits by modifying seeds, a sexual means of plant production. With the great success achieved with seeds, private seed companies advocated for IP protection for their investments in GM seeds. They achieved this through the US, which is home to most GM companies, hence the number of agricultural patents in the country has risen dramatically.<sup>66</sup> Initially, patent protection was not considered suitable for plant varieties. This is because, before biotechnology developments in this regard, any new plant varieties were not considered inventive, since they would be obvious to a person skilled in the art.<sup>67</sup> Hence, they could not qualify as patentable inventions and were regarded as mere discoveries. However with the capacity to develop transgenic plants through biotechnology, resulting in new plant varieties, it became possible to patent plant varieties, particularly those that have been genetically modified. In the light of this, TRIPS requires the protection of plant varieties through article 27(3)(b), which stipulates:

“Members may also exclude the following from patentability:

... (b) plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. *However, Members shall provide for the protection of plant varieties either by patents or by an effective sui generis system or by any combination thereof ...*”<sup>68</sup>

63 K Satoko “GMO trade in the context of TRIPS: From the perspective of an autopoietic system analysis” (2011) 10 *Ritsumeikan International Affairs* 243 at 248–50.

64 Oczek “In the aftermath”, above at note 12 at 637.

65 GMO Literacy Project “Biotechnology intellectual property law”, available at: <<https://sites.psu.edu/gmoliteracyproject/current-legislation/biotechnology-intellectual-property-law/>> (last accessed 31 March 2017); Stein “Intellectual Property”, above at note 62 at 165.

66 DM Strauss “The application of TRIPS to GMOs: International intellectual property rights and biotechnology” (2009) 45 *Stanford Journal of International Law* 287 at 289.

67 Blakeney *Intellectual Property Rights*, above at note 1 at 28.

68 Emphasis added.

It is clear from this provision that countries that are parties to this agreement can choose to protect the IP in plant varieties by establishing a patent system or a *sui generis* system [laws made specially to protect plant variety rights] or a combination of both. Although the agreement is silent on the specific *sui generis* system, the one used in most countries is based on the International Convention for the Protection of New Varieties of Plants (UPOV Convention) administered by International Union for the Protection of New Varieties of Plants (UPOV).<sup>69</sup> It should however be noted that a country may choose to allow both forms of protection; this will still be TRIPS-compliant. This article therefore now deals with these two options for protecting modified germ plasm and the resultant issues.

### Patent protection

A patent is granted for any invention, whether product or process, in any field of technology, provided that it is new, results from an inventive activity and is capable of industrial application.<sup>70</sup> Plant varieties can be protected through patents in jurisdictions that permit this. The invention in the plant will however have to fulfil the requirements for patentability according to the patent laws of the country in question. Upon grant, a patent usually grants the patentee a monopoly over the invention for a period of 20 years.<sup>71</sup> The granted patent allows the patentee to prevent others without authorization from making, using, selling, importing, exporting, storing or manufacturing the patented product, which in this case is the patented seed.<sup>72</sup> A patent gives absolute protection and infringement is of “strict liability”, in the sense that an infringer’s motive is relatively irrelevant. Once a person is held to be infringing, without being protected by any exceptions or defences, that person is liable. This situation is absurd in plant patents, since a farmer whose field is inadvertently pollinated with pollens from a GM crop or where seeds from a field planted with GM crops have blown to the farmer’s land will be held liable for patent infringement. Hence, farmers who choose to raise non-GM crops can be held liable for infringement if their crops test positive for GM, even though the patented plant or seed came into their possession unintentionally.<sup>73</sup> The absurdity of this situation can be seen in the decision of the Canadian court in *Monsanto v Schmeiser*.<sup>74</sup>

Monsanto owned the patent for glyphosate-resistant canola crops, in that the seeds were resistant to the pesticide, Roundup. These GM crops were found growing on Schmeiser’s farm without a licence from Monsanto to do

69 The acronym UPOV is derived from the organization’s French name: Union Internationale pour la Protection des Obtentions Végétales.

70 TRIPS, art 27.1.

71 *Id.*, art 33.

72 *Id.*, art 28.

73 Kariyawasam “Legal liability”, above at note 21.

74 *Monsanto Canada, Inc and Monsanto Company v Percy Schmeiser and Schmeiser Enterprises* [2001] FC 256 (Can). See also Schmeiser’s appeal in *Monsanto Canada, Inc v Schmeiser* [2004] 1 SCR 902, 2004 SCC 34.

so. Schmeiser argued that he did not knowingly plant the seeds, as his intention was to grow non-GM crops and that the seeds must have been borne by the wind, thereby contaminating his field. Hence he argued that he should not be held liable for infringement since he did not knowingly acquire or plant the GM seeds. The court held that he knew or ought to have known that the plants were glyphosate-resistant when he saved their seeds in 1997 and planted them the following year. For the court, knowledge or intention is irrelevant to the question of patent infringement. The facts of growing the seed, reproducing the patented gene and cell and subsequently selling the harvested crops constituted using Monsanto's invention without permission and were thus an act of infringement. A similar decision was reached in *Monsanto Co v Dawson*.<sup>75</sup> These decisions do not consider the concept of an innocent infringer, which may be allowable in other types of IP rights. For instance under the Nigerian Copyright Act, where a person can prove that he did not know and was not reasonably expected to know that copyright existed in a work, the copyright owner is only entitled to an account of profits and not damages.<sup>76</sup> By this concept, the defendant must however not only claim that he did not purchase or knowingly plant the patented seeds. He must also not reasonably have known that he was planting patented seeds. Thus, where a farmer plants patented seeds that he realizes are exhibiting GM characteristics, the concept of an innocent infringer may not be available.

In order to secure their investments, through the use of contracts with farmers, seed companies do not permit farmers to replant the seeds after harvest. To do otherwise makes the farmers liable for breach of contract. In a bid to ensure the effectiveness of this clause in contracts, Genetic Use Restriction Technology, popularly known as "terminator technology", was introduced. This technology is based on a patent granted by the US Patent and Trademark Office to the US Department of Agriculture and the Delta and Pine Land Co, titled "Control of plant gene expression".<sup>77</sup> This technology ensures that, after one season, harvested seeds are virile and incapable of reproduction or that they lack the desirable traits of the original seeds, unless sprayed with specific chemicals that activate the right gene.<sup>78</sup> The technology was widely condemned for adversely affecting the historical and traditional rights of farmers to save seeds for replanting and selling in subsequent

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75 [2000] WL 33953542 (ED Mo 2000).

76 Copyright Act, Cap C28, LFN 2004, sec 16(3) provides: "Where, in an action for infringement of copyright, it is proved or admitted that an infringement was committed but that at the time of the infringement the defendant was not aware and had no reasonable grounds for suspecting that copyright subsisted in the work to which the action relates, the plaintiff shall not be entitled under this section to any damages against the defendant in respect of the infringement, but shall be entitled to an account of profits in respect of the infringement, whether or not any other relief is granted under this section."

77 Oczek "In the aftermath", above at note 12.

78 Kuyek "Intellectual property rights", above at note 61.

seasons.<sup>79</sup> Following uproar from various quarters as to the negative effects of this technology, particularly on food security, the technology was withdrawn and the major seed companies have insisted they will not pursue the technology.<sup>80</sup> Furthermore, the UN, through the Convention on Biological Diversity, issued a de facto moratorium against the use of this technology.<sup>81</sup> Nevertheless, some arguments still exist for the termination technology to continue.<sup>82</sup> There are usually based on the fact that no law actually provides protection for a farmer's right to save seeds.<sup>83</sup> Its proponents claim that the terminator technology would ensure that seed companies can recoup their investments and encourage them to develop new varieties that might otherwise never have been developed if IPR enforcement were difficult.<sup>84</sup>

### ***Sui generis* plant variety rights**

UPOV was established in 1961 to protect plant variety rights. There are currently two versions of the UPOV Convention in place: that of 1978 (UPOV 1978) and the latest revised version (UPOV 1991). For countries that are intending to join the convention, only UPOV 1991 is now open for accession. The convention establishes a *sui generis* system that was developed to protect the rights of plant breeders by ensuring that their effort and investment in developing new plant varieties are adequately rewarded. It grants patent-like protection to the genetic make-up of the protected plant variety. Under the convention, plant variety rights are granted for a variety that is new, distinctive, stable and uniform.<sup>85</sup> A plant variety is deemed to be new if, at the date the application is filed, neither propagating nor harvested material of that variety has been sold or otherwise disposed of to others by or with the consent of the breeder for the purpose of exploiting the variety. It is distinct if it is clearly distinguishable from any other variety whose existence is a matter of common knowledge. It is uniform if, subject to the variation that may be expected from the particular features of its propagation, it is sufficiently uniform in its relevant characteristics on propagation. A plant variety is stable if its relevant characteristics remain unchanged after repeated propagation.

Under UPOV 1978, the breeder has the right to produce the variety's propagating materials for commercial purposes, offer those materials for sale and market the materials.<sup>86</sup> UPOV 1991 expands these rights to include reproducing or multiplying the protected variety, conditioning it for propagation, exporting and importing the variety, and stocking it for any of these

79 SM Ohlgart "The terminator gene: Intellectual property rights v the farmers' common law right to save seed" (2002) 7/1 *Drake Journal of Agricultural Law* 473 at 473.

80 H Stein "Intellectual property", above at note 62 at 168.

81 Strauss "The application of TRIPS", above at note 66 at 300.

82 Oczek "In the aftermath", above at note 12.

83 Id at 651.

84 Id at 656.

85 UPOV 1978, art 6; UPOV 1991, arts 5–9.

86 UPOV 1978, art 5.

purposes.<sup>87</sup> Although UPOV 1978 provides for the farmer's rights (to reuse, share, exchange and sell farm-saved seeds) and the research exemption, UPOV 1991 narrows the scope of these exemptions, thus expanding the scope of the breeder's rights. With regard to the breeder's exemption, UPOV 1978 permits the utilization of the protected variety as an initial source of variation for the purpose of creating other varieties or for the marketing of such varieties without the permission of the protected variety's owner.<sup>88</sup> Under UPOV 1991, breeders and researchers can use protected plant varieties to create new varieties, although this does not apply to new varieties that are "essentially derived" from those protected varieties.<sup>89</sup> This provision was added in order to prevent breeders from making minor, non-essential or cosmetic changes to an existing variety and subsequently applying for IP protection.<sup>90</sup>

With regard to the farmer's rights, UPOV 1978's focus on commercial exploitation implicitly allows the non-commercial use of the protected materials without the need for the breeder's authorization.<sup>91</sup> The scope of this exemption depends on national laws. While some jurisdictions only limit it to replanting the seeds, others permit the sale of limited quantities of the seed, a practice often referred to as "brown bagging".<sup>92</sup> Under UPOV 1991 the farmer's privilege is limited in that farmers may save seeds for future use "on their own holdings," but only "within reasonable limits and subject to the safeguarding of the legitimate interests of the breeder".<sup>93</sup> Hence farmers may no longer sell or exchange seeds with other farmers. This restriction has been criticized as being contrary to farming practices in many developing nations where seeds are exchanged to facilitate crop and variety rotation.<sup>94</sup> The limitation on the farmer's rights is likely to exacerbate the already existing problems of hunger and malnutrition.<sup>95</sup> It must be stated that these exemptions under the UPOV Convention are the main distinguishing factors between the UPOV *sui generis* system and patent protection, thereby making the UPOV Convention a better platform for ensuring that the interests of the IP owner and of the public are well balanced. By broadening the rights of the plant breeder and further restricting allowable acts, UPOV 1991 has made the UPOV system more similar to patenting plant varieties.

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87 UPOV 1991, art 14.

88 UPOV 1978, art 5.3.

89 UPOV 1991, arts 14.5 and 15.

90 LR Helfer and GW Austin *Human Rights and Intellectual Property: Mapping the Global Interface* (2011, Cambridge University Press) at 383.

91 UPOV 1978, art 5.1.

92 Helfer and Austin *Human Rights*, above at note 90 at 384.

93 UPOV 1991, art 15.2.

94 Helfer and Austin *Human Rights*, above at note 90 at 384.

95 Blakeney *Intellectual Property Rights*, above at note 1.

## ISSUES ARISING FROM GM CROPS AND IPRs

GMOs are a welcome development, in that they have the capacity to increase both the quantity and quality of food produced for the world's population. With increased yield and quality, hunger, which is a major problem, can be combated effectively. It has indeed been argued that GM crops offer great advantages to developing countries in particular, since they can resist environmental pressures, provide nutrition and be grown in places that do not necessarily have rich soils.<sup>96</sup> There are high expectations that GMOs will be able to help solve problems of agriculture, poverty and hunger since they will increase the amount of food produced and help feed the world's growing population.<sup>97</sup> In addition, GM crops decrease the need for pesticides and herbicides, thus reducing farmers' costs in this regard. They are also protected from predators such as insects, bacteria, fungi and animals.<sup>98</sup> It is therefore essential to ensure that seed companies continue to have IP protection to serve as a reward for their investment, as well as an incentive for continued research and development in this field.

However, the flip side is that, given current realities and seed company practice, the promise of GMOs increasing global food resources may actually be far from being achieved. One of the arguments against the IP protection of GMOs is that it increases the price of seeds and consequently the price of food.<sup>99</sup> GM seeds are more expensive than conventional seeds and the farmers have to contract with the seed company not to replant harvested seeds.<sup>100</sup> In addition, without an adequate research exemption it will be difficult to obtain seeds for research. Publicly funded research centres will not have access to the seeds and are usually challenged by poor government funding in this regard.<sup>101</sup> There is indeed a likelihood that certain crops will benefit from the IP system. However, the profit oriented seed companies will only be interested in investing or conducting research on those plants that have the potential to bring large financial returns, to the detriment of many other staple foods upon which the world's population relies.<sup>102</sup> Since these companies have also been the ones sponsoring research in this field, it may therefore be difficult

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96 Satoko "GMO trade", above at note 63.

97 Ibid. S Zarrilli "International trade in GMOs and GM products: National and multilateral legal frame works" (UN Conference on Trade and Development, *Policy Issues in International Trade and Commodities Study Series No 29*, 2005) at 1.

98 Kariyawasam "Legal liability", above at note 21.

99 Satoko "GMO trade", above at note 63; "Current intellectual property rights, especially those for GMO seeds, threaten poor farmers, food security and the right to food" (21 October 2009) *World Hunger Notes*, available at: <[http://www.worldhunger.org/articles/09/global/united\\_nations.htm](http://www.worldhunger.org/articles/09/global/united_nations.htm)> (last accessed 20 March 2017).

100 Kariyawasam "Legal liability", above at note 21.

101 Blakeney *Intellectual Property Rights*, above at note 1.

102 "Current intellectual property rights", above at note 99.

to obtain unbiased research in this regard.<sup>103</sup> Consequently, commercial seed companies may dominate agricultural research.

Environmental concerns about GMOs include the possibility of an adverse effect on society's gene pool, in that increasing dependence on GMOs can threaten the world's biodiversity.<sup>104</sup> Since GM crops can be resistant to adverse environmental conditions, diseases, insects and chemicals, this may conversely increase the susceptibility of non-GM crops to these hazards, thereby leading to their extinction.<sup>105</sup> Furthermore, in some countries where GM seeds are used, many other varieties have become extinct because a majority of farmers plant only the GM seeds. Planting GM crops reduces the incentive for farmers to experiment with informal plant breeding that is capable of creating plant varieties that can adapt to local growing conditions.<sup>106</sup> Wildlife on farms is also likely to reduce since weeds are destroyed, thereby reducing the available food for birds and insects. Hence there are fears that GMOs can destabilize the entire ecosystem.<sup>107</sup> "The very same societal benefits that intellectual property protection allegedly engenders – new crops with desirable characteristics – may in fact be detrimental to sustainable food and agriculture".<sup>108</sup> Furthermore, most of these seed companies are located in developed countries and their research is mostly geared towards developing crops in their environment and not necessarily that commonly found in other countries. They have been accused of not being interested in actually tackling the critical problems of the poor or of staple crops that form the bulk of the world's food supply.<sup>109</sup> Furthermore, issues of bio-piracy can also arise. Many developing countries are concerned that developed countries take some traits or part of their germ plasm, refine it and resell it to them.<sup>110</sup> The companies in developed countries are able to access these genetic resources freely, since developing countries consider them a common good or a common heritage of mankind.<sup>111</sup> Thereafter they are refined, patented and resold to developing countries.

## RECOMMENDATIONS AND CONCLUSION

Despite all these challenges, IPRs are needed for encouraging innovation and investment in this field. Without the ability of seed companies to obtain IPR

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103 "Do seed companies control GM crop research?" (1 August 2009) *Scientific American*, available at: <<https://www.scientificamerican.com/article/do-seed-companies-control-gm-crop-research/>> (last accessed 20 March 2017).

104 Satoko "GMO trade", above at note 63.

105 Ibid.

106 Helfer and Austin *Human Rights*, above at note 90 at 381.

107 Kariyawasam "Legal liability", above at note 21.

108 Helfer and Austin *Human Rights*, above at note 90 at 380.

109 Id at 380.

110 Stein "Intellectual property", above at note 62.

111 Strauss "The application of TRIPS", above at note 66.



protection for their inventions, the incentive to be involved in biotechnology and the development of new traits will disappear and the benefits of these technological advancements will be lost.<sup>112</sup> We should therefore seek how to balance the interests of IP owners with those of the public. Having signed TRIPS, countries must comply with their international obligations. Hence they should make provisions for the protection of plant varieties under the patent system and / or a *sui generis* system. In order to ensure the balance of interests, provisions protecting an innocent infringer should be incorporated into patent or plant variety protection laws in order to avoid cases such as *Monsanto v Schmeiser*.

Another flexibility that developing countries may exploit is the use of compulsory licences for plant patents under article 31 of TRIPS, where the patent on the plant variety can affect food security. Similarly, the UPOV Conventions permit the limitation of the breeder's right in order to protect public interests.<sup>113</sup> Countries must however ensure that such restrictions on the IP in patents or plant variety rights are necessary in the circumstances to curb severe and widespread malnutrition or hunger. Such restrictions would probably not be justifiable where the plants involved are ornamental. Developing countries must also develop *sui generis* systems that comply with their international obligations yet also take into consideration the country's level of development and local needs. Such countries can tailor their IP regimes to their circumstances and developmental priorities by maximizing the flexibilities allowable in TRIPS.<sup>114</sup> This means that policy and law makers should not simply lift legislation and policies from advanced jurisdictions without adjusting them to fit into their local environment. Hence, patenting life forms may be exempted from patent protection on the grounds that it is contrary to morality and public policy. Article 27(2) of TRIPS provides: "[m]embers may exclude from patentability inventions, the prevention within their territory of the commercial exploitation of which [sic] is necessary to protect *ordre public* or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment, provided that such exclusion is not made merely because the exploitation is prohibited by their law".

Some countries therefore use this as a basis for not granting IPRs to GMOs or genetic plant resources. The refusal to grant patents to such isolated or purified genetic materials is usually based on moral or cultural opposition to private ownership of these genetic resources.<sup>115</sup> The question of whether GMOs

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112 Hamilton "Legal issues", above at note 38; Helfer and Austin *Human Rights*, above at note 90; Oczek "In the aftermath", above at note 12.

113 UPOV 1978, art 9; UPOV 1991, art 17.

114 Institute of Development Studies "Democratising biotechnology: Genetically modified crops in developing countries", available at: <[www.ids.ac.uk/biotech](http://www.ids.ac.uk/biotech)> (last accessed 20 March 2017).

115 Helfer and Austin *Human Rights*, above at note 90 at 387; Strauss "The application of TRIPS", above at note 66.

may be patented or not depends on the national laws of each country.<sup>116</sup> Where a country adopts the stance of refusing to grant patents for isolated or purified plant genes, it will still be TRIPS compliant, provided the refusal does not extend to modified or artificial plant gene sequences.<sup>117</sup> This is because artificial gene sequences are significantly different from naturally occurring substances; thus they are rightly regarded as inventions.

The problem with such a stance is that biotechnology and genetic engineering involve making use of isolated genes from natural sources or inserting genes into GMOs in a way that is different from how they exist in nature. Hence they are seen as an invention. Furthermore, this argument did not succeed in a European case involving the Harvard oncomouse.<sup>118</sup> The oncomouse is a good example to illustrate how various jurisdictions view the aspect of patenting genetic manipulation of animals in particular.<sup>119</sup> In the US, patent no 4,736,866 was granted to Harvard College for a transgenic oncomouse. In Europe, the case involving the oncomouse was lengthy and raised several issues. In 2004, the European Patent Office Board of Appeal finally decided that, based on the utilitarian principle, the mouse was patentable.<sup>120</sup> This meant that the substantial medical benefit from the patent outweighed the moral concerns about the suffering caused to the animals by the gene. Importantly, the board held that the exclusion on patenting animal varieties did not constitute a ban on patenting animals as such. In Canada, the Supreme Court of Canada decided that higher life forms were not patentable, since they are not “a manufacture or composition of matter within the meaning of invention” under the Patent Act.<sup>121</sup>

Clearly, the concept of morality and “*ordre public*”<sup>122</sup> can affect the extent of the patentability of life forms, although in many developed countries patenting GM crops is acceptable and the dilemma is over patenting higher life forms, such as mammals. These cases indicate however the importance of *ordre public* and public morality in limiting the grant of patents over life

116 Satoko “GMO trade”, above at note 63.

117 L Dan and M Flitner “Intellectual property rights and plant genetic resources: Options for a *sui generis* system” *Issues in Genetic Resources* (no 6, June 1997), available at: <[https://www.biodiversityinternational.org/fileadmin/\\_migrated/uploads/tx\\_news/Intellectual\\_property\\_rights\\_and\\_plant\\_genetic\\_resources\\_497.pdf](https://www.biodiversityinternational.org/fileadmin/_migrated/uploads/tx_news/Intellectual_property_rights_and_plant_genetic_resources_497.pdf)> (last accessed 20 March 2017). The Oncomouse is a genetically modified mouse which is highly susceptible to cancer. The introduction of certain oncogene triggers the growth of tumours, hence it is useful for research on cancer.

118 Strauss “The application of TRIPS”, above at note 66 at 307.

119 See generally “Bioethics and patent law: The case of the oncomouse” (June 2006) *WIPO Magazine*, available at: <[http://www.wipo.int/wipo\\_magazine/en/2006/03/article\\_0006.html](http://www.wipo.int/wipo_magazine/en/2006/03/article_0006.html)> (last accessed 20 March 2017).

120 Board of Appeal of the European Patent Office, decision of 6 July 2004, T 315/03.

121 *Harvard College v Canada* (Commissioner of Patent) 2002 SCC 76.

122 The term “*ordre public*” is derived from French law. It expresses concerns about matters threatening the social structures that tie a society together, in other words, matters affecting public policy or morality.

forms. The situation in many developing countries may however be different, in that the gene pool and biodiversity in these countries are considered to belong to and be for the benefit of the entire community, hence monopolizing them would be contrary to the public policy of these countries. Although there are exceptions to patent protection, such exceptions are narrower than those available for plant variety rights. Article 30 of TRIPS requires that there should be “limited exceptions” that do not “unreasonably conflict with a normal exploitation of the patent” and “do not unreasonably prejudice the legitimate interests of the patent owner, taking account of the legitimate interests of third parties”. This three step standard makes it difficult for member states to be able to provide for exemptions that are similar to what exists under plant variety rights systems. Therefore, developing countries may be better off protecting GM crops through plant variety rights rather than patents, since such a system permits farmers’ rights and research exemptions, which have significant public welfare advantages.<sup>123</sup> These exemptions are important since they act as a safeguard for the public, especially in the light of food security concerns.<sup>124</sup>

Developing countries that have already signed the 1978 UPOV Act can maximize the use of farmers’ rights to save and reuse seeds as well as the research exemption, until there is local capacity to comply with the 1991 version. Furthermore, TRIPS only requires that a member state protects plant variety by patents or a *sui generis* system. It does not specifically provide that such a *sui generis* system must accord with UPOV. Hence, countries that have refused to sign either UPOV act can maximize this opportunity to develop a *sui generis* system tailored to balancing the public interest with the interests of the right owners. Public-private partnership should also be encouraged, in which the government, its research institutes and the seed companies can partner with each other, provide funding and cross license. Finally, in order to address the issue of bio-piracy, there can be an agreement to share the financial rewards from an invention with the country where the genetic materials originated. Licences to use such inventions for breeding programmes and research in the country of origin can also be granted.<sup>125</sup>

In conclusion, countries should weigh the risks and benefits of GM crops before adopting them and must ensure that they will not affect the environment or people’s health. Stakeholders can help state their opinions and canvass their fears about how GM crops can affect them or be helpful to them. Developing countries should invest in biotechnology research and the training of scientists, which would help in developing various sectors of their societies. There should be adequate awareness of the products that contain GMOs through appropriate labelling, so that consumers are able to make informed choices in respect of the food they purchase.

123 Gordan “Genetically modified crops”, above at note 3.

124 Blakeney *Intellectual Property Rights*, above at note 1 at 28.

125 Gordan “Genetically modified crops”, above at note 3.