Briefing Paper

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Agrochemical giant DuPont to sell Bolivian sorghum gene

by Edward Hammond

Introduction

In 2012 multinational giant DuPont plans to begin selling sorghum varieties containing a valuable gene taken from a sudangrass that was collected in 2006 in Bolivia.[1] DuPont has branded the gene "Inzen A II", and it makes sorghum plants tolerant to herbicides made by DuPont and other companies. DuPont has acquired an exclusive licence to the Bolivian herbicide tolerance gene from Kansas State University. The latter has filed for patents in the US and under the Patent Cooperation Treaty[2] on the gene and plants that contain it.

DuPont hopes to expand its position across the sorghum seed market with the Bolivian resource by producing and selling Inzen A II sorghum, and licensing the gene to other seed companies. Inzen A II sorghum will be co-marketed with the herbicide quizalofop, which DuPont sells under the brand name "Assure II".

Sorghum is harvested on about 3 million hectares in the United States every year, and DuPont's subsidiary, Pioneer Hi-Bred, also sells sorghum seed in countries such as Argentina, Australia, Brazil and Mexico.

The case appears to be one of biopiracy by a US university in collusion with a major multinational chemical and biotechnology corporation.

Kansas State University (KSU), DuPont and the two professors who claim to be the "inventors" of the Bolivian gene have refused to explain how they acquired the Bolivian seed. The seed that yielded the gene was collected on a Bolivian farm in 2006, 12 years after Bolivia's 1994 ratification of the Convention on Biological Diversity (CBD).

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Despite repeated requests, KSU, DuPont and the so-called inventors of the Bolivian gene have produced no documentation of prior informed consent or an access and benefit-sharing agreement with a legally competent entity in Bolivia, yet they are poised to profit from the Bolivian gene. Citing the information as confidential business, KSU also refuses to reveal the financial terms of its agreement with DuPont.

Unless KSU or DuPont have made such arrangements without making them public, the case is almost certainly biopiracy. This could result in demands against the company and the university at the CBD and in countries where the gene is patented or sold, particularly outside the United States.[3]

Background: Sorghum and sudangrass

An African native, cultivated sorghum (*Sorghum bicolor*) is now grown all over the world, especially in warmer semi-arid regions. It is technically a type of grass and is closely related to several other grasses. Some of these, such as johnsongrass (*Sorghum halepense*), are often considered weeds. Other relatives, including sudangrass (*Sorghum bicolor* ssp. *drummondii*),[4] can be crops themselves.

Cultivated sorghum crosses with some of its grassy relatives, including sudangrass. This can create fertile offspring that can be further bred, including crossing the hybrid back to sorghum cultivars (and vice versa). By using this method of conventional plant breeding, KSU and DuPont scientists transferred the Bolivian herbicide tolerance trait to commercial sorghum varieties. There is also a developed commercial market for sorghum-sudangrass hybrids themselves.

As its name suggests, like cultivated sorghum, sudangrass has been spread from Africa to other parts of the world. Sudangrass can be grown for grain, but is far more typically grown as forage or hay for livestock. The date that sudangrass was introduced to Bolivia is unclear. In several other Latin American countries, it was introduced in the early 20th century and has since become adapted to these countries.

Research interest in sorghum, including sorghum-sudangrass hybrids, is growing for two reasons. Firstly, sorghum has low water requirements compared to maize and other crops. Drought and water scarcity are set to become more frequent problems as a result of climate change, and this has revived interest in sorghum because it may be particularly well suited for future climate conditions.

Secondly, sorghum's flexibility has attracted the biofuels industry. About one-third of the sorghum grain grown in the United States now goes into the production of ethanol[5] rather than feeding people or animals. In addition, the juice of sugar-producing sweet sorghum varieties is fermented into biofuel ethanol. Forage-type sorghum can also produce large amounts of biomass in a short time, making it a potentially efficient source of cellulosic ethanol.

The patent applications

KSU lodged US and international patent applications on the Bolivian gene on 11 January 2008. The international application (WO2008089061), under the Patent Cooperation Treaty, was published on 24 July 2008. Publication of the US application (US20100115663) was delayed until 6 May 2010.

Among its claims, the KSU patent application covers the Bolivian ACC[6] herbicide resistance

gene, which was isolated from a sudangrass accession denominated Bol-71, and ACC-herbicide-tolerant sorghum plants produced with it. The patent application also claims *any* sorghum hybrid that is resistant to ACC herbicides. Patent examiners have, however, cast doubt on the novelty of these broadest claims. (Scientists have previously suggested that ACC tolerance genes from other sources might be genetically engineered into sorghum.)

While some of the broader claims may not survive patent examination, the core claims on the Bolivian gene and plants produced from it appear likely to proceed. The international patent application declares that KSU will seek patents across the world, including Bolivia's neighbour Brazil and most of Africa and Asia.[7] World Intellectual Property Organization (WIPO) data indicates that KSU is pursuing patent applications in 34 European countries (including Turkey), Russia and Australia, although this data is incomplete and further patent applications may exist that are not recorded by WIPO.

The KSU patent application does not provide any information about the source of the Bolivian gene except that it came from "wild" sorghum called "Bol-71". No further information about Bol-71 is given, apart from the fact that it was collected in Bolivia along with 82 other sorghum accessions. A review of scientific literature yields no scientific publications concerning the Bol-71 accession, leaving its origin a mystery.

The lead "inventor" of the Bolivian gene is Mitchell Tuinstra, an American geneticist and plant breeder. Since the patent applications were filed, Tuinstra has left KSU and he is now a professor at Purdue University. Tuinstra's co-inventor is Kassim Al-Khatib, a weed scientist originally from Iraq. Al-Khatib has also left KSU and is now at the University of California at Davis.

A month after the patent applications were filed, in February 2008, KSU and DuPont jointly announced that DuPont had exclusively licensed the gene for commercialization.[8] The financial terms of the deal were not released. The agreement also included a KSU-identified tolerance gene for ALS-type herbicides. That gene reportedly comes from a variety of sorghum from the United States.

ACC herbicide tolerance in Bolivia

Although KSU's patent applications refer to the gene source only as "wild sorghum", in recent interviews, Al-Khatib has clarified that Bol-71 is a sudangrass.[9] In January 2010 he told the US farm press: *"We identified a resistant gene in Sudangrass. Resistance is strong and is a single gene. We back-crossed to elite lines of sorghum and found exceptional resistance."*[10]

It is notable that the gene comes from sudangrass because in 2000 an investigator for Bolivia's Centro de Investigación Agrícola Tropical (CIAT-BO)[11] first reported resistance to ACC herbicides in Bolivian sudangrass. The resistant plants, possibly weeds, were growing in or near soya fields located north and east of the city of Santa Cruz de la Sierra, in the Provinces of Obispo Santiesteban, Sara and Chiquitos. This remains the only reported case of ACC herbicide resistance in sudangrass in the world, according to the International Survey of Herbicide Resistant Weeds.[12]

Tuinstra and Al-Khatib thus did not originally identify ACC herbicide resistance in sudangrass. Bolivian public sector researchers were the first to do so. Subsequent to the CIAT-BO report, Tuinstra and Al-Khatib apparently decided to acquire and screen Bolivian sudangrass. Motivations to do so are obvious: Kansas is the leading US state in sorghum production (closely trailed by Texas) and Pioneer Hi-Bred (a DuPont

subsidiary) maintains a sorghum research facility in Manhattan, Kansas, where KSU is also located. It is potentially profitable for both if they can patent new herbicide resistance genes.

Tracking the origin of Bol-71

Where exactly did the Bolivian gene come from? Who collected it, when and how did it get from South America to Kansas? Since there are no scientific publications on Bol-71, the answers lie with those that are claiming it as their invention.

Before publication of this report, KSU, DuPont, Tuinstra and Al-Khatib were all contacted with a number of questions. DuPont and Al-Khatib did not reply. Tuinstra replied *"you are looking for intrigue where none exists"* and declined to provide details, citing a confidentiality agreement with KSU.[13]

The KSU Research Foundation, which manages the University's intellectual property, enigmatically replied, *"The germplasm was collected in 2006 from random weed samples in soybean fields in Bolivia pursuant to a contract. No one from Kansas State University collected these samples."*[14]

While providing a date, and again confirming the Bolivian origin, KSU did not identify: who collected the seed; the parties to the contract, or how the seed came into KSU's possession.

A 2006 KSU Agronomy Department publication[15] reveals that it has maintained a long-term relationship with *"a large soybean grower in the Santa Cruz region."* This is the same area of Bolivia where CIAT-BO identified ACC resistance in sudangrass. Two KSU agronomy professors have repeatedly made working visits to the soya operation. One of the professors is a herbicide resistance specialist. The 2006 publication noted that the KSU agronomists went to Santa Cruz five times between 1998 and 2005.[16]

Oddly, no scientific publications that directly relate to the long-term Bolivian research could be identified from either professor. If there are no research publications, then the nature of the collaboration remains unclear.

While KSU's refusal to provide additional details makes it impossible to conclusively link the two with information currently available, it seems likely that KSU's relationship with the large soya grower in Santa Cruz is related to the collection of Bol-71.

KSU was asked what benefit-sharing agreement it has in place with the Bolivian government or other Bolivian institution(s). It replied by refusing to confirm or deny the existence of an agreement, stating *"This is considered business confidential."*[17]

KSU was repeatedly requested to provide the contract under which it claims Bol-71 was collected. There was no reply to these requests.

Mystery agreement between Kansas State University and DuPont

The agreement between KSU and DuPont defines who is profiting from the Bolivian gene, but its terms have not been made public.

Typically in the United States such a technology licence would provide for an initial cash payment from DuPont to KSU, followed by royalty payments based upon DuPont's sales of the licensed product. A percentage of KSU's proceeds would be paid to the "inventors", as determined by a pre-existing intellectual property agreement between KSU and its research employees.

The timing of the licence agreement indicates that DuPont knew about the research at an early stage.

The agreement was announced in February 2008, only a month after the patent applications were filed and well before their publication. This suggests that KSU and DuPont had agreed to cooperate on sorghum herbicide resistance well before 2008. It is possible that the cooperation predates acquisition of the Bolivian seeds in 2006, making DuPont not only the licence holder, but also potentially a participant in the procurement of the Bolivian germplasm.

KSU, DuPont and the "inventors" of the Bolivian gene would not answer questions about their financial arrangements and relationship. Although KSU is a public entity, it declined to disclose what money it has received from DuPont and what royalties it and the "inventors" will receive, saying the information is *"business confidential"*.

In response to enquiries as to where it will pursue patent rights, KSU replied that this *"will become known to the public as the applications are published."* KSU also declined to clarify if DuPont's licence to the gene is global or only for certain countries, again saying the information is *"business confidential"*.[18]

Prior informed consent and benefit-sharing agreement (or lack thereof)

KSU's assertion that Bol-71 was collected *"pursuant to a contract"* outwardly suggests that some form of prior informed consent (PIC) and/or benefit sharing may exist. Closer examination, however, casts strong doubt on whether such consent and agreement – if any exists at all – meets ethical and CBD standards or those required by Bolivian law.

There is no indication that KSU has any relation to government or other entities in Bolivia in this matter other than a mysterious cooperation with a Bolivian soya producer. In the case of the producer (and/or collector), KSU has not produced the purported contract or explained its scope.

Even if the alleged contract that KSU refuses to make public contains PIC and benefit-sharing arrangements with KSU's collaborator in Santa Cruz, it does not appear that these would satisfy the requirements of Bolivian law. In Decree 24676 of 1997, Bolivia implemented Andean Community Decision 391 on Access to Genetic Resources. Among other provisions, Bolivia's implementation of Decision 391 requires that those seeking access to Bolivian genetic resources obtain permission and execute an access contract with the Bolivian government. This contract, among other things, requires a governmental partner in the research programme and for the Bolivian government to assume a just and equitable interest in any economic benefit or technology arising from the genetic resources.[19]

Further, Bolivia's political constitution of 2008 prohibits private appropriation and exclusive use of Bolivian biodiversity, establishes the right and responsibility of the state to defend, recover, protect and repatriate its biodiversity, and establishes that illegal trafficking and use of biodiversity will be criminally sanctioned.[20]

This report conclusively determines that the ACC herbicide resistance gene was taken from Bolivia in 2006 and has been privately appropriated by KSU and exclusively licensed to DuPont. The investigation found no evidence that KSU has complied with the requirements of Decree 24676. It also appears that the patenting, licensing and sale of the gene does not comply with the Bolivian Constitution.

Bolivian experts should study these legal matters further. KSU must produce the contract under which they say the Bolivian gene was collected without delay.

DuPont's plan

While DuPont's licence of the Bolivian gene was announced in 2008 (before the gene's origin was revealed), it was not until 2010 that DuPont began to seriously promote its new product to US farmers.

The public relations campaign opened in March 2010 at a large farming industry gathering. DuPont's biggest selling point for the Bolivian gene is that the sorghum will tolerate "over the top" applications of tank-mixed herbicides. In other words, farmers can spray the chemicals directly onto their plants, killing susceptible weeds, while leaving the crop unscathed. This method of weed control, massively popularized in the US by Monsanto's "Roundup Ready" glyphosate-tolerant crops, has previously not been possible with sorghum.

DuPont's brand name for herbicide-resistant sorghum seeds is "Inzen".[21] Seeds that contain the Bolivian gene are called "Inzen A II". The "A II" refers to "Assure II" (quizalofop p-ethyl), DuPont's brand of ACC herbicide. The ALS resistance trait in sorghum from KSU that DuPont also licensed is called "Inzen Z", for "Zest", a DuPont brand of ALS herbicide.

The main weeds Inzen A II/quizalofop target are sandbur (*Cenchrus longispinus*), johnsongrass (*Sorghum halepense*) and shattercane. Shattercane is thought to have resulted from crosses between forage sorghums and other plants in the *Sorghum* genus and is particularly closely related to cultivated sorghum.

The Bolivian gene is scheduled to go on the US market in 2012, initially as a single trait in sorghum varieties. The company says it will begin to stack the Bolivian gene with the ALS resistance gene (in conventional varieties) in 2013, resulting in plants that resist both ACC and ALS herbicides.

In addition to selling the Bolivian gene in DuPont's own Pioneer Hi-Bred sorghum seed, DuPont says that it is negotiating with a number of other sorghum seed companies to license the trait to them, meaning that "Inzen A II" sorghums with the Bolivian gene may be sold by other companies. In 2010, DuPont showcased the Bolivian trait in field trials to farmers in 11 US states.[22] DuPont says that it will provide information on seed prices in 2011.[23]

There are questions as to how long the resistance genes will work in the field. ALS-herbicide-resistant shattercane has already been reported in seven US states, and ACC- or ALS-resistant johnsongrass has also been reported in seven US states and on large acreage in nearby Mexico.[24] DuPont says that it is developing plans to avoid resistance. It also says resistance in sorghum may be managed in conjunction with management of glyphosate resistance in other crops, through farmers adopting rotation systems that rely on using multiple herbicide modes of action in different years.[25]

Conclusion

Kansas State University and DuPont have privately appropriated a valuable herbicide resistance gene collected in Bolivia in 2006. They are pursuing patents around the world on the gene and intend to commercialize it in 2012. The gene has a high commercial potential.

KSU and DuPont have refused repeated requests to explain exactly how they acquired the gene and what makes them believe that they are its rightful owners. Unless the two are inexplicably hiding valid access and benefit agreements, KSU and DuPont have colluded to commit biopiracy.

As a Party to the Convention on Biological Diversity, Bolivia has constitutional and other legal protections over its biodiversity that appear to have been flouted by KSU and possibly others involved in this case. It appears likely, but there is no certainty, that KSU's long-term relationship with a large soya grower in Bolivia's Santa Cruz region is linked to KSU's acquisition of the Bolivian sudangrass.

There is a heavy ethical and legal burden on KSU, DuPont and the "inventors" of the Bolivian gene to explain and justify their actions, something that they have refused to do thus far by hiding behind "business confidential" claims. No confidential business claim can justify theft and biopiracy, or abrogate KSU and DuPont's responsibilities.

A number of steps must be taken to publicly establish more facts and to stop this highly probable case of biopiracy:

First, KSU (a public institution) and DuPont must immediately produce all agreements and material transfer documentation relating to the collection of Bol-71 in Bolivia and its export to the United States, so that the facts regarding the physical collection and shipment of the accession may be assessed and verified by the Bolivian government and independent experts.

Second, KSU must immediately suspend its pursuit of patent claims over Bol-71 until the validity of its acquisition and possession of Bol-71 can be established. If it cannot be established, then KSU must abandon these claims.

Third, DuPont's move to commercialize the gene must be suspended due to unresolved biopiracy questions. This must include the suspension of DuPont's efforts to sub-license the "Inzen A II" gene to other sorghum seed companies. Those seed companies should be made aware that DuPont and KSU's claim to exclusive ownership of this Bolivian gene may be invalid.

Finally, ongoing inter-governmental negotiations to produce an internationally legally binding Access and Benefit Sharing Protocol under the CBD are at the final stages. Developing countries including Bolivia are demanding a strong protocol with international rules and compliance systems to prevent biopiracy. The Bol-71 case reaffirms the need to ensure that research institutions and research use are not exempted or treated less stringently in the protocol, as demanded by several developed countries and industry lobbyists.

Notes

1. Sudangrass (*Sorghum bicolor* ssp. *drummondii*) is also written as "Sudan grass". Because this report makes frequent reference to the names of countries, for the sake of clarity the spelling "sudangrass" is used.

2. The Treaty is administered by the World Intellectual Property Organization, and the filing of a single application has the same effect as national applications filed in the countries of interest to the patent applicant. An applicant seeking patents may file one application and request protection in as many PCT member states as it wants. This process saves time and money for a patent applicant.

3. All United Nations members are Parties to the CBD except Andorra, the Holy See and the United States.

4. Many sources use the older scientific name, *Sorghum sudanese*.

5. United Sorghum Checkoff Program. 2009. Sorghum Use in Ethanol on the Rise (news release). 23 November. http://www.sorghumcheckoff.com/sorghum-use-ethanol-rise

6. ACC stands for acetyl coenzyme A carboxylase.

7. Bolivia itself is not a member of the Patent Cooperation Treaty; neither are its immediate neighbours, except for Brazil. KSU may pursue patents in non-PCT countries through national patent offices. Bilateral agreements with the US may also impact KSU's international rights when a US patent is issued.

8. Kansas State University. 2008. DuPont Crop Protection and Kansas State University Research Foundation Partner to Commercialize Sorghum Herbicide Tolerant Traits (press release). 6 February. http://www.ksre.ksu.edu/news/sty/2008/DuPont_crop020608.htm

9. Although farmers and scientists can clearly distinguish cultivated sorghums and sudangrasses, taxonomically speaking sudangrass is a type of sorghum. Thus, the KSU patent application is accurate in calling it "sorghum", even though the choice of descriptors is much less precise than could be hoped for in a patent application. (With KSU refusing to produce information about Bol-71, it is unclear if the term "wild" is accurate or not.)

10. Smith R. 2010. Weed control challenge for sorghum producers. *Southwest Farm Press*. 26 January. http://southwestfarmpress.com/grains/sorghum-weed-control-0126/ See also: Dreiling L. 2010. Researchers on path for herbicide-resistant sorghum. *High Plains/Midwest Ag Journal*. 10 March. http://www.hpj.com/archives/2010/mar10/mar15/0222SorghumMACO09_ldsr.cfm

11. CIAT-BO (in English: Center for Tropical Agriculture Research) is part of the government of Santa Cruz Department. It is not part of the Consultative Group on International Agricultural Research (CGIAR)'s Centro Internacional de Agricultura Tropical (CIAT) in Colombia.

12. International Survey of Herbicide Resistant Weeds. 2010. Group A/1 Resistant Sudangrass (*Sorghum sudanese*) – Bolivia. http://www.weedscience.org/Case/Case.asp?ResistID=1149 (accessed 14 June 2010).

13. Tuinstra M. Professor of Agronomy, Purdue University. 2010. Personal communication. 15 June.

14. Molina M. Vice President. KSU Research Foundation. 2010. Personal communication. 17 June.

15. KSU. 2006. *K-State Agronomy: A Century Remembered.*

16. Ibid. p. 60.

17. Molina M. 2010.

18. Ibid.

19. Republic of Bolivia. 1997. Decreto Supremo No. 24676. 21 June.

20. Republic of Bolivia. 2008. Nueva Constitución Política del Estado.

21. US Patent and Trademark Office. Trademark Electronic Search System. 2010. "Inzen" (database entry). URL: http://tess2.uspto.gov/bin/showfield?f=doc&state=4008:83qkka.2.1

22. Anonymous. 2010. Sorghum Checkoff to showcase new herbicide technology. Kansas AgLand. 1 June. http://ksagland.com/index.php?option=com_content&view=article&id=3622

23. Hays R. 2010. DuPont Uses Commodity Classic Sorghum General Session to Unveil Inzen Trait Line for Sorghum Industry. Oklahoma Farm Report. 4 March. http://www.oklahomafarmreport.com/wire/agri-innovations/02440_DuPontInzenSorghum03042010_144849.php

24. International Survey of Herbicide Resistant Weeds. 2010.

25. Anderson K. 2010. Coming soon: Inzen herbicide-tolerant grain sorghum. Brownfield Ag News. 12 May. http://brownfieldagnews.com/2010/05/12/coming-soon-inzen-herbicide-tolerant-grain-sorghum/