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# Chinese Sorghum to Enrich Texas Agrofuel Industry

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A sorghum plant collected in 1956 at a Chinese government agricultural experiment station is under patent claim by Texas A&M University in the United States. Texas A&M says the sorghum is valuable because of a trait that permits hybridization between sorghum and other species that can be used to create new agrofuel crops.

Texas A&M obtained the Chinese sorghum from the John Innes research center in the United Kingdom, which itself received the sorghum from a German seed bank. Texas A&M did not breed the Chinese sorghum to obtain the key trait it claims, rather it was already there and was described in scientific literature at least 20 years ago.

In Patent Cooperation Treaty publication WO2010011935, as well as US patent applications 20100064382 and 20100050501, Texas A&M claims the hybridization gene from the Chinese sorghum, its use in sorghum breeding, the resulting sorghum plants, the creation of crosses with other species, and the resulting interspecies hybrids themselves.

Texas A&M sees the Chinese gene as a profit center for the University and as the way for it to become a major player in the development of agrofuel crops. Texas A&M already has a huge collection of sorghum seeds, many of which originate in Africa. With the Chinese gene, the University will be able to move traits from the diverse sorghum collection it holds into new kinds of agrofuel interspecies hybrids.

Texas A&M's first goal is to acquire firm patent control over the gene and plants containing it. Its first product goal is to create sorghum-sugarcane hybrids for agrofuel production. In parallel it is proceeding with a longer-term program to cross sorghum with maize and other species, and selecting resulting plants for agrofuel purposes.

Texas A&M has existing agrofuel partnerships with seed companies including Ceres and energy companies including Chevron. It is now discussing additional investment with energy giant Shell, specifically to develop agrofuel plants using the Chinese gene. The University's ambitious plans even include a proposal to the US Department of Defense to power US Air Force jets with fuel from plants bred from the Chinese sorghum.

The case draws attention to the urgent need for the following:

- Assessing the importance of the Nagoya Protocol on Access and Benefit Sharing under the Convention on Biological Diversity, and understanding how it would apply to *ex situ* collections of germplasm acquired before the entry into force of the Convention and of the Protocol;
- Patent and other intellectual property rights offices as a checkpoint to monitor and expose potential biopiracy;
- Awareness among policy makers, academia and the public on the inequitable nature of patents and other intellectual property rights claims over genetic resources; and
- A comprehensive national law on Access and Benefit Sharing in developing countries.

How did a sorghum collected in China more than fifty years ago come to be claimed as the property of Texas A&M University in the United States?

**Background: Kaoliang Sorghums**

Sorghum was domesticated in Africa but has a long history in China. Exactly when sorghum arrived in China is the subject of scholarly debate, although it came at least two thousand years ago and perhaps much earlier.[1] Sorghum arrived in China after first stopping in India, where it is also an important crop. Over the millennia that sorghum has been grown in China, Chinese farmers have adapted it to their conditions, including those in the country's north, at notably higher latitudes than most of Africa and India.

The distinct sorghum varieties that Chinese farmers have created are collectively called "Kaoliang sorghums". Kaoliang is a Chinese word meaning sorghum that is also the name of a liquor distilled from sorghum grain. Kaoliang sorghums have distinctive characteristics, including cold tolerance, early maturity, and photoperiod insensitivity,[2] which reflect selection by Chinese farmers for their environmental conditions.

**Collection of the Texas A&M Kaoliang Sorghum**

Texas A&M's acquisition of the kaoliang sorghum that it is seeking to patent is an ironic accident of 1950s international socialist solidarity. Although research firmly establishes that the sorghum came from China, Texas A&M does not admit to the full set of facts regarding its Chinese origin, including in its patent applications.

The sorghum can be traced to a government agricultural research station in Hulan (**呼兰区**), outside the city of Harbin in China's northeastern Heilongjiang Province (formerly called

[1] Kimber CT. **Origins of Domesticated Sorghum and its Early Diffusion to China and India**. Chapter in Smith CW and RA Fredericksen (eds). 2000. **Sorghum: Origin, History, Technology, and Production**. Wiley.
[2] Meaning that the plant will mature under the longer daylight conditions of higher latitude summers, a trait often absent from sorghums developed in the tropics.

Manchuria). It was collected in 1956 by scientists from Leibniz Institute of Plant Genetics and Crop Plant Research (called IPK-Gatersleben) in what was then the communist German Democratic Republic (East Germany).

With precision, the IPK-Gatersleben scientists' account of their expedition specifies that they visited the visited the Hulan Experiment Station (*landwirtschaftlichen Versuchsstationen*) on August 2$^{nd}$ and 3$^{rd}$ 1956, and states that they collected sorghum seeds there.[3] Seven sorghums that they collected at Hulan were returned to East Germany and deposited in the IPK-Gatersleben gene bank.

The sorghum claimed by Texas A&M is recorded by IPK-Gatersleben under the name "SOR-7"; but in more recent UK and US scientific literature it is referred to by the name "Nr481" (the sequence number originally given to it by the collecting expedition scientists).[4]

Unfortunately, there is no information in Western scientific literature to indicate what exactly the Chinese agronomists at Hulan were doing with Nr481, nor does the German expedition report explain why Nr481 was selected to take to Germany. Nr481's presence at the experiment station establishes that Chinese scientists found it worthy of attention. It is unclear, however, if it is a farmers' variety collected for a breeding program, an unusual type collected for a specific characteristic, germplasm bred at Hulan, or of some other origin.

At some point before the late 1980s, the seed was acquired from IPK-Gatersleben by Cambridge University in the UK.[5] In a 1989 study, Cambridge and Kew Botanical Gardens researchers identified that Nr481 was unusually permissive to pollination from other species, although in their brief experiment they failed in their objective to viably hybridize Nr481 with maize.[6]. The Cambridge University researcher who documented Nr481's pollination oddities in 1989 later moved to the UK's John Innes Center, taking Nr481 with him.

Texas A&M acquired Nr481 from the John Innes Center in 2003 or 2004.[7] With government research funding, in 2006, A&M researchers published results indicating they had crossed it with different species in the *Sorghum* genus.[8] By July 2008, they had gone a step further and filed for a patent, covering use of Nr481 and its genes to cross sorghum with more distantly related species, particularly sugarcane, but also millets, maize, and other plants. The patent applications claim all

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[3] Institut Für Kulturpflanzenforschung. 1957. C. **Allgemeiner Bericht über die Chinesisch-Deutsche Biologische Sammelreise durch Nord- und Nordost-China im Mai bis September 1956**. http://springerlink.com/content/r451555651qg4nu4/fulltext.pdf

[4] IPK Gatersleben. 2010. **Genebank Information System: Entry for SOR-7.** http://gbis.ipk-gatersleben.de/gbis_i/home.jsf (accessed 8 September 2010) and Laurie, DA. 2010. Personal Communication. 20 May.

[5] Laurie, DA. 2010. Personal Communication. 20 May.

[6] Laurie DA and MA Bennett. 1989. **Genetic Variation in Sorghum for the Inhibition of Maize Pollen Tube Growth.** Annals of Botany 64.

[7] Rooney W. 2010. **Passport/History and General Characterization Information for NR481**. Memo prepared in response to Texas Public Information Act request of 17 May 2010 to Texas Agrilife and provided to the author.

[8] Price HJ et al. 2006. **Genotype Dependent Interspecific Hybridization of *Sorghum bicolor***. Crop Science 46.

crosses and resulting plants that use the Nr481 genes, particularly crosses with other grasses that share the C4 photosynthesis pathway.

Texas A&M officials have little to say about Nr481's origin. They profess to be ignorant of, and uninterested in, where Nr481 came from. When asked directly if they are aware that the sorghum was collected at a Chinese government agricultural experiment station, the inventor and senior A&M research officials did not respond.[9]

In reply to a formal legal request for information about how they acquired the Chinese sorghum, Texas A&M merely stated that Nr481 came from the John Innes Centre[10] in the United Kingdom "*sometime around 2003 or 2004*". And as if to preemptively cast doubt about the origin of the sorghum, A&M attributes information about a Chinese origin to British researchers, unwilling to confirm so much itself.

A memorandum prepared by the "inventor", William Rooney, further suggests that Nr481 might not be a kaoliang sorghum but be of another sorghum group (durra), although he concedes that Nr481 "*possesses traits typical of the Chinese Kaoliangs*."[11] Texas A&M's patent application and other documents,[12] including A&M funding proposals, also muddy the waters by suggesting that Nr481 has "*wild*" parentage, that its key gene(s) are "*wild type*", and that it has "*poor genetic background*" with "*very undesirable agronomic characteristics*".[13]

Even as they patent its genes and stake very broad claims for its use in plant breeding, A&M repeatedly suggests that Nr481 is undesirable. The historical record, however, establishes that Chinese scientists first noted value in Nr481, that it was selected in the 1950s by German scientists for further evaluation, and that its unusual pollination characteristic was identified more than 20 years ago by British scientists. And, of course, the process of moving genes from a plant adapted to one place and set of conditions (1950s China) to a different genetic background (e.g. Texas ethanol production in 2010) is the *sine qua non* of most plant breeding programs, including Texas A&M's.

A&M's "badmouthing" of Nr481 thus appears disingenuous - a bit of willful historical ignorance calculated to suggest that A&M has created immense value from a worthless wild weed. That is, by confusing and diminishing the significance of Nr481's origin, A&M is seeking to increase the appearance of innovation by the University. In fact, A&M did not breed Nr481 to obtain its key characteristic, and A&M has done little other than to appropriate existing knowledge and resources that were already identified as valuable and provided by others.

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[9] Personal Communication with William Rooney ("inventor"), Craig Nessler (Director, Texas Agrilife Research), and Bill McCutchen (Associate Director), College Station, TX, 22 June 2010.
[10] The Cambridge University researcher who documented Nr481's pollination oddities in 1989 later moved to the John Innes Center, apparently taking Nr481 with him.
[11] Rooney W. 2010. **Passport/History and General Characterization Information for NR481**.
[12] Texas A&M University. 2009. **High-Biomass Energy Crops for U.S. Energy Security** (funding proposal to DARPA). September. Obtained under the Texas Public Information Act.
[13] Rooney W et al. 2009. **Intergeneric Hybrid Plants and Methods for Production Thereof.** US Patent Application 20100050501. (Published 4 March 2010.)

**A&M's Plan: Leverage Nr481 to Become a Key Player in the Agrofuel Industry**

Texas A&M imagines the blossoming of a very large-scale agrofuel industry based on hybrids between sorghum and other species enabled by a Nr481 gene called "iap".[14] The University articulated its vision in a 2009 funding proposal submitted to the Defense Advanced Research Projects Agency (DARPA), a research arm of the US Department of Defense. With substantial salesmanship – Texas A&M describes the Nr481's trait as a "*wide-hybridization technology platform*":[15]

*Texas A&M University will create and deliver advanced high yielding energy sorghums and new energy crops through a novel, non-GMO, wide-hybridization technology platform. These unique energy crops will be sustainable, high yielding, widely adapted, drought tolerant, optimized for biofuels and biopower generation, thereby significantly improving US biofuels and biopower production capability and long-term energy security.*

Although Texas A&M is a public institution, it has determined to take a highly proprietary and business-oriented approach with the Chinese sorghum technology. A&M is marketing "wide hybridization" (or "promiscuous sorghum" in the illustration below) to the seed and energy industries under complicated licensing schemes and non-disclosure agreements, leaving A&M's other partners and farmers out in the cold, and with no consideration for the Chinese origin of A&M's "invention".

[14] "iap" stands for "inhibition of alien pollen". Written in lower case, it refers to a recessive trait found in Nr481 that is permissive to sorghum pollination by other species. Written "IAP" or "Iap" (i.e. with upper case), it refers to the trait normally found in sorghum plants, which stops pollen from other grasses from successfully pollinating sorghum. iap's function has been demonstrated; but the gene is not yet mapped.

[15] Texas A&M University. 2009. **High-Biomass Energy Crops for U.S. Energy Security** (funding proposal to DARPA). September. Obtained under the Texas Public Information Act.

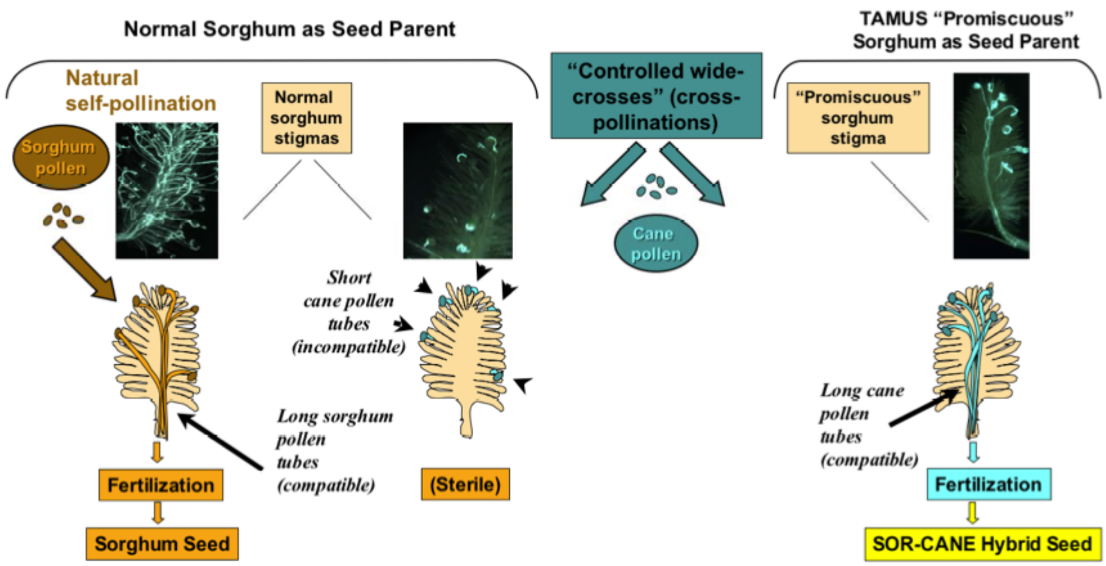


**FIGURE 3. Diagrammatic representation of wide-hybridization technology for sorghum (*Sorghum bicolor*): normal sorghum stigmas are highly "self-compatible", i.e., with sorghum pollen (left), but highly incompatible with alien pollen (center), pollen tubes of which are forced to cease growth soon after emergence, thus precluding fertilization. In the specially bred TAMUS "promiscuous" lines of sorghum, the alien pollen is much more compatible (right) resulting in pollen tube growth, which thus permits fertilization, embryogenesis and formation of F1 seed.**

(From Texas A&M University. 2009. **High-Biomass Energy Crops for U.S. Energy Security.)**

As Texas A&M officials paint the scenario, they feel obliged to be secretive and proprietary about the Chinese sorghum because they allege that private industry has previously used A&M crop research (notably in cotton) without adequately compensating the University.[16] Thus, A&M has assembled a commercialization team for Nr481 that includes a former senior GE crop developer for DuPont and an intellectual property staffer from the University of California at Berkeley, where he was involved in a highly controversial deal that gave Syngenta (then part of Novartis) significant rights over university research.[17]

In personal communications and internal e-mails obtained under the Texas Public Information Act, Texas A&M officials have no detectable sensitivity to the fact that others, including Chinese and African farmers, may feel that Texas A&M's patent claims are unfair to them in a manner similar to how A&M feels about how it has been treated by multinational seed companies. Texas A&M's official feel that their massive sorghum germplasm collection, which rivals (and duplicates much of) that of the Consultative Group on International Agricultural Research, belongs to Texas A&M and nobody else.

The University has resisted and delayed responding to public information requests about Nr481. Through what that has been made available, however, particularly an accidentally released funding proposal to the US Defense Department, much of A&M's plan has been revealed.

[16] McCutchen, W. 2010. Personal Communication. College Station, TX, 22 June 2010.
[17] Scheurman, P. 2010. Personal Communication. College Station, TX, 22 June 2010.

A&M's early targets for "wide hybridization" include creating fertile agrofuel sorghum-sugarcane hybrids grown from seed. These unusual hybrids would contain the full genome each parent plant, and would mix traits from both species. As sugarcane is normally reproduced by vegetative propagation, the hybrid seed is potentially a new market for seed companies and a labor saving development for farmers.

A&M also plans to use the Chinese gene to create at least 10,000 new crosses between sorghum and other C4 grasses every year for the next five years. In parallel, it is seeking new funding to "digitally genotype" its sorghum seed collection to bring forward agrofuel traits. A&M's goal is to winnow these large populations of new crosses down to about 1,000 that show development promise by 2015.[18] In addition to funding from the US Defense Department, Texas A&M is also seeking a deal with Shell Oil for Nr481 development.[19]

**DuPont's Influence at Texas A&M**

Texas A&M may also put commercial herbicide and insect resistance genes into Nr481-derived agrofuel seeds. Biochemical giant DuPont appears to have an inside track to putting its genes into varieties that are commercialized.

In 2009, DuPont approached A&M's lead sorghum breeder proposing that he use its herbicide resistance genes[1] in A&M sorghum.[1] An apparently inconclusive meeting took place in mid-September.

The following month, Texas A&M's Associate Director for agricultural research again pushed the breeder to put commercial resistance traits into A&M sorghum. In an e-mail titled "Confidential", the Associate Director proposed that A&M sorghum scientists hire a postdoctoral student to study the possibility in "wide hybridization" (i.e. Nr481) hybrids. Unusually, the senior administrator proposed that he would personally oversee the work of the post-doc in other scientists' labs.[1]

The intervention of the Associate Director raises conflict of interest concern. Until 2006, the Associate Director was a product developer for DuPont, where he was responsible for transgenic herbicide resistance traits. The Associate Director was aware that DuPont was also lobbying the breeder to use its proprietary traits.

The Associate Director's behind-the-scenes pressure for A&M to put commercial genetic engineering traits in its sorghum, particularly those owned by his former employer, as well as his desire to personally supervise the relevant research, at a minimum creates the impression that DuPont has acquired an improper level of influence inside the public university.

[18] Texas A&M University. 2009. **High-Biomass Energy Crops for U.S. Energy Security** (funding proposal to DARPA). September. Obtained under the Texas Public Information Act.

[19] Rooney W. 2009. Electronic mail to other A&M officials. 12 August 2009. Obtained under the Texas Public Information Act. Rooney is professor and "inventor" of the Nr481 trait.

**Conclusion**

One of the most controversial and difficult issues for the negotiations of the Nagoya Protocol on Access and Benefit Sharing, that was adopted by the Conference of the Parties to the CBD on 29 October 2010, was benefit sharing from the utilization of genetic resources acquired before the entry into force of the CBD and the Protocol, most of which are now in *ex situ* collections in developed countries.

Developing countries argued that "new and continuing" uses of such *ex situ* genetic resources should be covered by the Protocol so that country of origin or country that provided the resource in accordance with the CBD can also have their fair share of benefits. As this case of the Chinese sorghum shows, the country of origin of an important genetic resource with tremendous commercial value can be left with no share of the benefits. Worse, foreign institutions now claim the "ownership" of the important traits and indirectly of the resource.

The Protocol provides for a new global multilateral benefit sharing mechanism. It states that:
"*Parties shall consider the need for and modalities of a global multilateral benefit-sharing mechanism to address the fair and equitable sharing of benefits derived from the utilisation of genetic resources and traditional knowledge associated with genetic resources that occur in transboundary situations or for which it is not possible to grant or obtain prior informed consent. The benefits shared by users of genetic resources and traditional knowledge associated with genetic resources through this mechanism shall be used to support the conservation of biological diversity and the sustainable use of its components globally*."

In this mechanism, the benefits will be used "*to support the conservation of biological diversity and the sustainable use of its components globally*" and it is not clear how the sharing will be done with the country of origin. Therefore it will be necessary to interpret and understand what this provision means when the Protocol enters into force. Will a case such as China's sorghum be included? And will countries in such a situation be able to receive some of the benefits?

This case study also shows the importance of patent and other intellectual property rights offices as a checkpoint to monitor and expose potential biopiracy. Developed countries rejected the explicit inclusion of these offices as a mandatory checkpoint established under the Protocol – China together with all developing countries strongly wanted this but the final compromise did not make this mandatory. It is now up to each Party to the Protocol to decide if patent and other IPR offices will be a checkpoint.

More fundamentally this case study again illustrates the inequitable nature of patents and other intellectual property rights claims over genetic resources, and it would be useful for developing countries to continue to participate actively in the review of the patenting of life forms provisions in the WTO Agreement on Trade-related Aspects of IPRs (TRIPs).

Finally, developing countries urgently need to establish and implement a comprehensive national law on Access and Benefit Sharing so as to prevent biopiracy of their biodiversity and associated traditional knowledge, and to ensure that they get their fair and equitable share of benefits.