AFRICAN SORGHUM FOR AGROFUELS

the race is on

A Briefing Paper by the African Centre for Biosafety

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Contents

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The African Centre for Biosafety (ACB) is a non-profit organisation, based in Johannesburg, South Africa. It provides authoritative, credible, relevant and current information, research and policy analysis on genetic engineering, biosafety, biopiracy, agrofuels and the Green Revolution push in Africa.

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Acronyms

CGIAR	Consultative Group on International Agricultural Research
GE	Genetically engineered
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
INTSORMIL	International Sorghum and Millet Collaborative Research Support Program
ITPGRFA	International Treaty for Plant Genetic Resources for Food and Agriculture
MTAs	Material Transfer Agreements

Introduction: Agrofuels and Sorghum

The interlocking problems of climate change, emissions from fossil fuels, and limited oil reserves have stimulated interest worldwide in the use of plant crops to produce fuel. Agrofuels are not a new idea. Brazil, for instance, has used them on a large scale for many years. The potential scale of production and use of agrofuels in the coming decades, however, is unprecedented.

Presently, most of the world's agrofuels are produced from common crops including maize and sugarcane (for ethanol) and soya and rapeseed (for biodiesel). But dozens of companies and public sector plant breeding institutions, funded by private and government investment, are furiously researching other crops that could be optimized for agrofuels. This is in part due to the criticism that has been levelled at production of agrofuels from edible grains, particularly maize, and its effect on food prices.

Sorghum, native to Africa and grown world- wide, is fast emerging as a leader among the "energy crops" and may play a major role in the international agrofuels industry. Seed companies are showing new interest in African farmers' varieties of sorghum, which have characteristics useful for industrial agrofuel production. Companies and government plant breeders are making patent and other intellectual property claims over these African seeds. One such company, Ceres Inc, is profiled in this paper, along with its research collaborator, Texas A&M University.

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) provides for benefits to accrue to Africa in return for use of its seeds, either housed in gene banks or recently collected in the field. Thus far, however, this Treaty does not appear to be effective in protecting African sorghum.[1]

This paper presents an overview of the basic types of sorghum and the different technologies used to extract agrofuels from them. It then examines the secretive research collaboration between the California-based Ceres corporation and Texas A&M University to commercialise agrofuel sorghum seed, which relies on African sorghum without returning benefits to Africa.

The Race to Claim Sorghum Genes for Agrofuels

Sorghum was first domesticated in Africa and is now cultivated worldwide. Historically, it has received less attention from commercial plant breeders than maize and other plants, in part because it has been perceived as "poor man's food". With changing climate and agricultural priorities, however, sorghum is finding new suitors in developed and developing countries, especially for the production of agrofuels.

Proponents of sorghum for agrofuels argue that sorghum does not bring with it the "food vs. fuel" dilemma as is the case with maize because, in the North, sorghum grain is generally not consumed by humans. This perspective obviously ignores the fact that sorghum grain is a

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Sorghum bicolour

staple food crop for many, especially in Africa, and that diversion of sorghum into agrofuel production and conversion of land to sorghum agrofuel production may in fact have the same deleterious effect on food prices as growing maize for agrofuel.

Sorghum has many attractive characteristics for those who wish to use it as feedstock for agrofuels. Sorghum is highly drought tolerant and requires little inputs – especially water. Sorghum can produce grain but also, depending on the variety, can in a single season yield as much sugar as sugarcane or as much biomass (dry matter) as any other field crop.

Sorghum seeds used in industrial agriculture are a small representation of sorghum's genetic diversity. Attracted by sorghum's potential, but limited by the narrow gene pool of current industrial cultivars, proponents of agrofuel sorghum are engaged in a race to find and claim as their own agrofuel-related characteristics in farmers' sorghum varieties.

Leading the charge are US, European, and Indian industrial interests. Because the vast majority of farmers' varieties of sorghum are African, intellectual property rights on sorghum genes will privatize resources that are currently under the control of African farmers, either in farmers' fields or in gene banks pledged to using varieties to promote food security in developing countries (and not the economic interests of agrofuel conglomerates).

While North-funded efforts are underway to collect African farmers' varieties in the field, for the most part, those who are interested in sorghum for agrofuels are engaged in sifting through the contents of gene banks, where seeds collected from African farmers decades ago are being stored.

Foremost among these gene banks is the World Sorghum Collection, where sorghum seeds are held under the auspices of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India, which in turn is part of the Consultative Group on International Agricultural Research (CGIAR). Other important gene banks outside Africa include government institutions in the United States, France, and India.

The World Sorghum Collection at ICRISAT

Notwithstanding opposing claims by the private sector, the world's largest and most important collection of sorghum seeds can be found at ICRISAT in Patancheru, India. Now numbering more than 37,000 accessions,[2] most of ICRISAT's collection is held in-trust under the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA), which requires sharing of benefits when ICRISAT seeds are used commercially.

ICRISAT has sorghums from across the world, but the largest numbers and most important diversity comes from Africa. Many of ICRISAT's seeds were collected in the field or bred by CGIAR plant breeders. Large portions of the collection, however, were handed over to ICRISAT by other institutions in the 1960s and 70s.

Key components acquired "in bulk" from predecessor seed banks include a large collection of sorghum assembled by the Rockefeller Foundation in the 1960s from breeders and other sources worldwide. This included material from the national collections of the United States and India, and a large collection provided by ORSTOM, the French government development research agency now known as IRD (*Institut de recherche pour le développement*).

The Rockefeller, US, and ORSTOM collections in particular contain many African farmers' varieties of sorghum, many of which were collected during colonial times. Seeds from the national agricultural research systems of African countries themselves are also part of ICRISAT's genebank, including large collections from Ethiopia and Sudan, both key countries for sorghum diversity.[3]

Types of Sorghum

All cultivated sorghums are of the same species, *Sorghum bicolor*. Within *S. bicolor* there is tremendous diversity. There are tens of thousands of farmers' varieties and breeding lines of sorghum.

Sorghums are also grouped by end-use. The basic end-use types are grain, forage, and sweet sorghums.

Grain Sorghum is the most frequently grown type in traditional and industrial agriculture. It is primarily grown for its seed head, which bears edible grain. In Africa, most sorghum grain is destined for human consumption (including brewing), whereas in most industrialized countries, sorghum grain is primarily consumed by livestock. There is large variation in colour, composition, and other characteristics of grain sorghum varieties, and farmers and plant breeders divide them into many subtypes. Many of these subtypes can be traced to specific areas of Africa, where they were originally developed.

Especially in industrial agriculture, grain sorghums are bred to be shorter than other types, typically reaching about a meter. This height facilitates mechanical harvesting and reduces lodging (falling over) caused by wind, rain, and weight of the seed head (panicle). The stalks and leaves of grain sorghums can be fed to livestock.

Forage Sorghum is typically a long, tall type grown primarily for its leaves and stalk, which are fed to animals.[i] Industrial forage sorghums may grow up to 3 meters high or even taller, although there are some shorter types bred for heavy leafy growth and others that are grazed in the field. Generally, the entire plant (except roots) is harvested, processed, and fed to livestock. Ranchers, dairies and feedlots are all markets for forage sorghums.

Forage sorghums are rebounding in popularity in the United States as an alternative to silage maize. The nutritional content for cattle of forage sorghum can meet or exceed that of silage maize, while forage sorghums are more drought tolerant and demand less fertilizer and water. Many forage sorghums can be thought of as the original "high biomass" sorghum and are currently the inspiration for current efforts to market "high biomass" sorghum for the production of cellulosic ethanol for use as fuel, rather than fodder.

Sweet Sorghum is primarily cultivated for its sugary stalk, resembling that of sugarcane. Juice pressed from sweet sorghum stalks can be boiled down to syrup. This syrup is consumed in Africa, India, and less commonly in the United States.

While sweet sorghum rivals sugarcane in sugar content, its juice composition is not suited for the production of crystallized sugars, like that extracted from sugarcane. Because sweet sorghum can be processed with essentially the same equipment and using the same process as sugarcane, there is significant interest in using sweet sorghum as a feedstock for the production of ethanol.

In addition to stalk sugars, sweet sorghum also produces grain. Grain maturity and stalk sugar levels coincide, which means that sweet sorghum is unusual among prospective "energy crops" in that they produce both sugar (fuel) and grain (food) in separate parts of the plant at the same time. This is notably different to maize, soya, and rapeseed, where the edible grain is converted into fuel, leaving nothing for human consumption.

Although grain yields from sweet sorghum are not as high as purpose-bred grain sorghums, these are high enough to constitute an important potential source of food and feed. And like other sorghums, once juiced, the crushed stalk (called "bagasse") may be fed to animals, composted, or burned as fuel.

ICRISAT is currently breeding dual-purpose sorghums that are both sweet-stalked and that yield high quality grain. It has released such varieties that are put to both uses.[4] In contrast, major US-based sweet sorghum breeding projects are attempting to make sweet sorghum a sugar only crop. They are doing this by eliminating the seed head to create varieties that yield no grain. This is accomplished through sterile hybrids and manipulation of photosensitivity traits.

i. Some "forage" sorghums have sweet stalks and/or produce significant grain.

Sweet sorghum farmers that grow open pollinated varieties for the nascent US sweet sorghum agrofuel market often chop off the seed head and allow it to fall to the ground prior to harvesting the stalk. At best, they may return later and collect the un-threshed grain for silage. Alternatively, some farmers harvest the seed head without separating the grain, allowing it to become part of the bagasse.

It should also be noted that many traits of interest for agrofuels, within high biomass and sweet sorghum varieties, are not traits that have recently received much attention from breeders. The tall, thick-stalked varieties for cellulosic agrofuels were seldom grown until recently, while US sweet sorghum cultivation (for syrup) had dropped almost to the level of an unusual backyard hobby, totalling little more than 10,000 hectares in the entire country.[5]

This means that the number of existing US varieties with agrofuel traits is very small. As a result, cellulosic and sweet agrofuel sorghum breeders have no choice but to look elsewhere for desirable traits and, when it comes to sorghum, Africa is the queen of diversity.

Ethanol Agrofuel from Sorghum

There are three main technologies for producing ethanol from sorghum, each of which is adapted to different sorghum types.

Ethanol from Sorghum Grain

Ethanol is produced from sorghum grains in an industrial process in which the grain starches are broken down into sugars, which are then fermented and distilled into ethanol. The process is essentially identical to that used for processing maize into ethanol. More than a quarter of the sorghum grain harvested in the US is now burned by motor vehicles, and a sorghum industry association is trying to increase that figure to 50% by 2011.[6]

Source: http://commons.wikimedia.org/wiki/File:Sorghum_bicolor_ssp_bicolor_3.jpg

Sorghum bicolour

Ethanol from High Biomass Sorghum

Cellulosic ethanol is produced by breaking down woody plant material into sugars that are fermented and distilled. Unlike production from grains, cellulosic ethanol can in theory, come from woody plant waste or purpose grown high cellulose crop.

The industrial processes involved are complex and are not currently economically viable on a large scale. As a result, cellulosic ethanol remains more promise than reality.

Nevertheless, the expectation exists that cellulosic ethanol will become an important energy source in the coming years, and thus there is interest in the development of "high biomass" field crops from sorghum to feed cellulosic ethanol refineries. Sorghums of interest for this purpose are types similar to forage sorghums. High biomass sorghums are bred to grow fast and tall, and to bear little (if any) grain.

There is significant corporate interest in the business of selling high biomass sorghum seed, as discussed below.

Ethanol from Sweet Sorghum

The process of producing ethanol from sweet sorghum is the simplest, because sugars are already produced in the plant stalk and do not need to be broken down from grain starch or cellulose. Converting these sugars into ethanol is essentially an identical procedure as that used for sugarcane. Stalks are squeezed, the juice fermented into "beer", and ethanol is distilled from the fermentation product. The fact that sweet sorghum ethanol production technologies are mature and well known (mostly due to Brazil's program) will mean that this relatively little-known sorghum type may come under much broader cultivation in coming years.

Climate and other Crop Considerations

Regional Variation in Seasons

Sorghum is grown in tropical and temperate zones worldwide. Techniques and varieties for future large-scale production of sorghum for agrofuels will vary depending on the prevailing climate. In warmer areas of India and much of Africa, sorghum can be sown twice and/or ratoon cropped,[ii] providing multiple harvests in a single year. In sugar producing countries such as Brazil, multiple harvests would be possible, but the harvesting of sugarcane occurs eight or nine months a year. Thus, for Brazil, agrofuel interest in sorghum mainly focuses on timing a single harvest of sweet sorghum for those months when sugarcane is scarce. The goal is to keep ethanol refineries running at full capacity all year-round. [7]

In more temperate zones, sorghum will not grow in winter and is sown once a year as a summer crop. With the exception of areas such as the southern extremities of the United States or northern Australia, a second sorghum crop or ratoon harvest is not possible. This has important implications for ethanol production, because unlike tropical zones, refinery feedstock is only harvested for a short season.

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ii. In a ratoon crop, the sorghum is allowed to grow back from its roots after the first harvest and then cut again. Under some conditions, a second ratoon (or third harvest) is possible before the field should generally be re-sown.

While grains may be easily stored with existing techniques and infrastructure, for sweet and forage sorghums, temperate zone seasonality means that sorghum varieties and/or storage methods will have to be developed to maintain the ethanol production potential of the freshly harvested crop for several months or longer since bio-refineries are far more economically viable if they operate year-round.

Photoperiod Sensitivity

Many varieties of African sorghum are photoperiod sensitive, which means that they are accustomed to tropical sunlight conditions of approximately 12 hours of light per day. These varieties will typically fail to flower and set seed when grown in the long-day summers of more northerly (or southerly) latitudes. In order to overcome this problem, temperate zone breeders have usually bred photoperiod sensitivity out of African (and other tropical) germplasm.

However, the development of sorghum for agrofuels is changing this practice. By retaining day length sensitivity, breeders can create sorghum hybrids that do not flower during the long summer and autumn days in temperate regions. Since high biomass sorghums are not grown for grain, and because many sweet sorghum growers are only marginally if at all interested in grain, non-seeding types of sorghum are not seen as a problem by some agrofuel proponents.

Breeding photoperiod sensitive varieties in temperate climates, particularly when coupled with (male sterile) hybrid technology, also serves the interest of seed companies as these varieties make it highly impractical for farmers to save seed.

Genetic Engineering

A serious ecological danger stemming from genetic engineering of sorghum lies in its close relationship to Johnsongrass (*Sorghum halapense*), a globally distributed crop and grass weed. Because sorghum and Johnsongrass are frequently found together and naturally hybridize, there is a strong possibility that transgenic sorghum could transfer its genetically engineered (GE) components to Johnsongrass, creating wild weed populations carrying undesirable GE traits.

Despite this clear biosafety risk, several players such as the Gates Foundation and Du Pont are involved in genetic engineering projects involving sorghum, including a project in South Africa.[8] Ceres Inc, profiled below, is involved in developing genetically engineered sorghums for agrofuel production. Ceres has not stated how it would overcome the Johnsongrass hybridization problem, nor prevent the contamination of food supplies with agrofuel GM sorghum grain. Ceres' emphasis on commercializing male sterile hybrids and other grainless sorghum types, however, suggests that sterility may be a key component of its strategy to bring GE agrofuel sorghum to market.

Sorghum Ethanol and the Seed Industry

Several seed companies are developing sorghum varieties for conversion to ethanol. These include Advanta, a seed brand with a long European history but which is now owned by United Phosphorus, India's largest agrochemical company. Advanta operates in more than 30 countries, including major seed operations in India, Australia, Thailand, and Argentina.[9]

Advanta has been expanding into the United States, most recently buying up the Texas-based independent company Crosby Seed, a sorghum specialist. Advanta claims to have the largest collection of sorghum germplasm in the world.[10]

Another Indian company, Praj Industries, designs and engineers ethanol plants worldwide. It also offers agronomic consulting services including in respect to sweet sorghum agrofuel varieties. Praj actively collaborates with ICRISAT.[11] ICRISAT is led by well known agrofuels enthusiast, William Dar, the former Secretary of Agriculture of the Philippines.[12]

In Brazil, the governmental agricultural research agency Embrapa has reactivated a sweet sorghum ethanol research program, which had been largely dormant since the 1980s (due to the dominance of sugarcane in Brazilian ethanol production).[13]

US-based Pioneer, owned by the DuPont chemical company, is a major vendor of grain sorghum seed used in ethanol production and, in some countries, forage sorghum.

One seed company, Ceres, is singularly focused on the development of sorghum agrofuel varieties. It has already commercialized two "high biomass" varieties.[14] Ceres has not partnered with ICRISAT but with Texas A&M University, the largest public sector sorghum breeder in the United States. As discussed in the subsequent sections, the Ceres-A&M partnership is concentrating on sifting through sorghum genebanks in the race to identify genes and varieties with ideal characteristics for ethanol production.

Ceres: The Aspiring Agrofuel Sorghum King

Ceres Inc. is a privately held company based in the city of Thousand Oaks near Los Angeles, California. It was founded in 1997 by Walter de Logi, the former chief of Plant Genetic Systems, a Belgian genetic engineering company now owned by the German giant Bayer.

Until 2004, Ceres was in the business of patenting and selling plant genes to other companies (e.g. Monsanto). Since then, it has been trying to transform itself into a multinational seed company specializing in energy crops, beginning with sorghum.[15] It has established a retail subsidiary called Blade Energy Crops to bring the agrofuel seeds to the market.

Ceres aims to become a major vendor of plant varieties sown for agrofuel production. It immodestly claims that it will "*revolutionize the energy industry and change the way we live.*"[16] Its investors include the firm Warburg Pincus and Monsanto, which have made

Source: http://upload.wikimedia.org/wikipedia/commons/8/84/Sorghum_bicolor03.jpg

Sorghum bicolour

investments of US $75 million and $137 million respectively. Other shareholders include Oxford Biosciences (US) and Soros Private Equity (US), an investment firm chaired by US billionaire George Soros.[17]

Although Ceres is a US-based company, European firms hold a large stake in it, and occupy key management and directorial positions. European shareholders include the Belgian investment firms KBC Group and Gimv, as well as the Artal Group.[18]

Artal is a quiet giant. Reputedly an investment vehicle for super wealthy Belgian families, Artal has interests in processed meat and other foods, including Kentucky Fried Chicken and other fast food outlets in Asia, Europe, and North America.[19 20 21] Ironically, Artal, the purveyor of fattening food also owns Weight Watchers, a business that counsels people trying to lose weight.[22]

Texas A&M University: Sorghum Seed Specialist

Texas, along with Oklahoma, Kansas, and other neighbouring states, are major US producers of sorghum. Texas A&M University's sorghum breeding program has traditionally been an important support for the US sorghum industry.

In its many decades of sorghum research, Texas A&M has amassed a very large number of sorghum seeds. These have been obtained by Texas A&M by two primary means. First, Texas A&M and the US Department of Agriculture have cooperated since the 1960s to "convert" and introduce mainly African farmers' varieties of sorghum into the Unites States.[23] These varieties are held in US national sorghum collections, including copies of materials held in-trust by ICRISAT.

Second, Texas A&M is a long-standing member of the US Agency for International Development's INTSORMIL program, an international research collaboration emphasizing US-Africa links. INTSORMIL's stated objective is to assist both the African and US sorghum industry through research activities including collection of African and other foreign germplasm.

Through its efforts, INTSORMIL has brought US $680 million per annum to the US sorghum industry.[24]

Ceres' Exclusive Deal with Texas A&M[25]

During October 2007, Ceres entered into a contract with Texas A&M, which places at the disposal of Ceres, a large sorghum breeding program supported since the 1950s (and perhaps earlier) by public funding.[iii] In terms of the deal, Ceres is given exclusive access to a large number of sorghum seeds held by Texas A&M. In this way, a significant part of Texas A&M's public research enterprise is turned into a de facto private arm of Ceres.

The contract includes the following:

- Texas A&M is prohibited from releasing any sorghum seed for breeding or commercialization that is 5% or more identical to the seeds optioned to Ceres,[iv]
- Texas A&M may not release any sorghum containing any gene of interest to Ceres,[26]
- Ceres has exclusive option to buy Texas A&M's interest in patent claims resulting from Texas A&M sorghum research, and
- Texas A&M researchers must submit research papers to Ceres and obtain the latter's prior approval before their publication.

The 2007 agreement emphasizes the development of high-biomass sorghums that are (male sterile) hybrid and photoperiod sensitive,[v] meaning that the plants typically will not set seed, especially in temperate climates. These priorities are in line with Ceres' ambition to control seed varieties and create "pure" agrofuel varieties from which no grain is harvested.

In 2008, Ceres and Texas A&M modified their agreement to emphasize research on sweet sorghum with the focus again being on male sterile photoperiod sensitive hybrids.[27] The current contract runs through late 2012.[28] The sweet sorghum preoccupation appears to be driven by the vagaries of US government ethanol subsidies as well as renewed interest in sweet sorghum in Brazil, where Ceres is also seeking to commercialize seed.[29]

In return for handing over resources and research to Ceres, Texas A&M will receive US $4.9 million over 5 years and options to buy Ceres' stock at a fixed price.[vi] Texas A&M will also receive royalties on Ceres' sorghum seed sales. In addition, a provision of the agreement grants agrofuel refineries, wholly or partially owned by Texas A&M, a discount on sorghum seed.

In April 2008, Texas A&M executed four material transfer agreements (MTAs) with Ceres under exclusive license.[30] In early 2009, Ceres placed its first four agrofuel sorghum varieties on the market. Two varieties (ES5200 and ES5201) are high biomass sorghums, while two others (ES5140 and ES5150) are high biomass sorghum-sudangrass hybrids.[vii]

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iii. Ceres signed a similar deal with the Samuel Roberts Noble Foundation of Oklahoma, for agrofuel switchgrass (*Panicum virgatum*) research.

iv. The precise meaning of this provision is unclear. Given the large genetic overlap between sorghum varieties (typically well above 90%), a literal interpretation would appear to give Ceres control of all sorghum held by Texas A&M. Of note, both Ceres and Texas A&M fought specifically to prevent public disclosure of this particular provision in the contract, perhaps due to its breadth.

v. Male sterile hybrids will set seed if pollinated by male fertile varieties sown nearby. Because the varieties are hybrids and seed would bear sterility genes, the resulting seed would likely present difficulties if sown again.

vi. The value of these warrants cannot be calculated because the stock is not publicly traded.

vii Ceres concedes that sales are minimal due to the very limited demand for cellulosic ethanol feedstock, however, the company sees value in being first to market for agrofuel-specific sorghum seed. (Swayze S. 2010. **Development of sweet sorghum for biofuels and biopower**. Presentation at the 2010 Sweet Sorghum Ethanol Conference, 29 January, Orlando, US)

The astonishingly short time frame between the execution of these MTAs and commercialization strongly suggests that Ceres has simply commercialized Texas A&M seed.

The Ceres and Texas A&M Agrofuel Sorghums: Where Did They Come From?

Ceres and Texas A&M are determined to prevent the public from learning about the origin of the sorghum seed they are using. In response to public information petitions filed on behalf of the African Centre for Biosafety, Ceres hired an attorney, Jeffrey Boyd, a former Deputy Attorney General of Texas. Boyd lodged several lengthy briefs against the African Centre for Biosafety, representing Ceres in proceedings with his former employer, the Attorney General. In these briefs, Ceres repeatedly sought to block disclosure of all information pertaining to the sorghum seeds by claiming that the identities and origin of all germplasm used in the joint program is a proprietary trade secret.[31]

Despite Ceres and Texas A&M's intransigence, it is likely that much of the germplasm is African. This can be demonstrated with a variety of evidence including the redacted (blacked out) research contracts that have been released to the public.

First, it should be recalled that the bulk of Texas A&M's sorghum collection has been acquired, directly or indirectly as farmers' varieties, mainly from Africa. These have come to Texas A&M through the INTSORMIL and USDA / Texas A&M Sorghum Conversion Programs.

Analysis of previous Texas A&M sorghum germplasm releases (for which parentage information is available) demonstrates A&M's heavy reliance on African seeds.[32] For example, in 2004 Texas A&M released 49 sorghum breeding lines en masse. All of the lines had their origin in farmers varieties held by the ICRISAT collection.[33] Of these, 38 (78%) were African: 10 Ethiopian, 8 Sudanese, 6 Nigerian, 3 Malian, 2 each from Kenya, Zimbabwe, Niger, and The Gambia, and 1 each from Mozambique, Somalia, and Malawi.[viii]

Even sorghum lines kept within Texas A&M's breeding program for many generations are dependent upon ICRISAT's in-trust germplasm. An example is RTx437, released in 2003. RTx437 was the result of an involved breeding process; with the key trait – higher grain yield in a white seeded variety – being provided by a Sudanese sorghum in the ICRISAT genebank (accession IS 2816).[34] A group of four breeding lines released in 2002 had two different Ethiopian parents.[35]

While the African origin of much of Texas A&M's sorghum does not alone prove that Ceres is selling "proprietary" seeds that are African, a telling passage in the heavily redacted Ceres-Texas A&M contract reveals more. It states as follows in relation to high biomass sorghums (emphasis added):[36]

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viii. The remainder: 9 from India, 1 from Puerto Rico, and 1 unknown.

Source: http://commons.wikimedia.org/wiki/File:Sorghum_bicolor_Bild0902.jpg

Sorghum bicolour

"*within the [Texas A&M] program,* ***we have identified specific genotypes from the world collections*** *that have even higher yield potential that would likely be superior for biofuels production … The manipulation of these lines to develop effective parents for high biomass sorghum hybrid production has been initiated.*"

The World Sorghum Collection is held by ICRISAT and is primarily composed of farmers varieties of sorghum, most of them African. "World collections" almost certainly refers to the ICRISAT collection or copies of in-trust ICRISAT material held at other genebanks. It is the identity of these seeds from the "world collections" that Ceres and Texas A&M claim is proprietary information.

Finally, Ceres has demonstrated unusual behaviour for a seed company with respect to intellectual property. Ceres states that a key goal of the company is to patent and sell agrofuel-related traits in sorghum. Despite its goal of privatizing sorghum, Ceres has not (yet) applied for plant variety protection or patents on the high biomass varieties it has commercialized and sweet sorghums it claims it will shortly commercialize.[37]

Despite its failure to seek patent or variety monopolies, Ceres claims all information about its varieties is proprietary by virtue of being a trade secret, and seed that it sells includes a grower license that warns farmers not to violate Ceres intellectual property, although no patents or variety protection (yet) exists.

Ceres' behaviour is aberrant from the usual business practice of seed companies (who tend to maximize intellectual property before going to market) and difficult to explain.

One possible reason why Ceres has not filed for plant variety protection is that it does not wish to divulge where its sorghums come from, which is at least theoretically required in order to obtain plant variety protection and might be required for a patent application.[ix] It thus may be seeking to rely on trade secrets, at least in the short term.

Alternatively, Ceres' varieties may simply fail to meet the criteria of being distinct, uniform, and stable and thus be ineligible for plant variety protection. Similarly, they may lack novelty or an inventive step and thus not meet the criteria of patentability.

ix. Ceres has a degree of "biological copy protection" built into its seeds through photosensitivity and hybridization, which makes saving seed by farmers difficult. Patent applications do not require disclosure of the origin of crop varieties per se, however, in some cases the origin can be inferred from other information included in the patent application.

These possibilities suggest that Ceres has not invested significant breeding effort into its varieties. This would be consistent with commercialization of "proprietary" germplasm that was selected by Texas A&M from African accessions.

Conclusion

The rush to profit from agrofuel sorghum clearly relies on the African farmers who domesticated sorghum and have developed the remarkable genetic diversity of this versatile crop. And it relies upon African farmers not solely because of the contributions made hundreds and thousands of years ago, but because it is dependent upon African seeds in a direct and contemporary way.

In the case of Ceres and Texas A&M, the obstructionist behaviour in which they have hidden behind trade secret claims, makes it difficult to say with certainty that they are directly appropriating African seeds. However, there is strong evidence to suggest that they are. Texas A&M is highly reliant on African germplasm found in the World Sorghum Collection, and it admits that seeds in the Ceres deal come from the international collection. The considerable effort that Texas A&M and Ceres have made to prevent public disclosure of the origin of their seeds further suggests that they have something to hide.

Texas A&M and Ceres' use of alleged trade secrets, especially if repeated elsewhere, further poses a serious challenge to the implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture. The Treaty requires benefit sharing when in-trust germplasm, such as that in the World Sorghum Collection, is used commercially. The treaty cannot be enforced and benefit sharing may not take place, however, if Texas A&M and Ceres (and others like them) keep the use of in-trust germplasm a secret. This may be happening and is a betrayal of the trust between governments that have signed and ratified that treaty.

To respond to these issues, African governments may wish to consider a number of concrete steps, including the following:

1. Re-evaluate the terms of participation in the US Agency for International Development's INTSORMIL program. INTSORMIL has provided some benefits for Africa such as scientific training; however, it has been far more profitable for the United States. African governments may wish to condition their continued participation in INTSORMIL on proper access and benefit sharing agreements, in line with the ITPGRFA, to cover all African germplasm used in INTSORMIL activities, whether newly collected in the field or retrieved from gene banks.

2. African governments may wish to convey to the Consultative Group on International Agricultural Research (CGIAR), and to ICRISAT in particular, their expectation that the CGIAR will be vigilant and active in ensuring that the ITPGRFA is honoured in the agricultural use of sorghum germplasm. ICRISAT is well aware of the burgeoning use of the World Sorghum Collection in agrofuel efforts; in fact ICRISAT is a participant in some

of them. ICRISAT needs to make a commitment to transparency and enforcement of the ITPGRFA in its various dealings with sorghum agrofuel developments, and it must avoid linking itself to any particular commercial effort in a way that compromises its ability to impartially discharge its stewardship role in regard to the sorghum collection.

3. African governments can register their concern about this issue at the next meeting of the parties to the ITPGRFA in Bali, Indonesia during March 2011. In particular, the danger to the treaty posed by Ceres-style claims of "trade secrets" regarding the identity and origin of commercial germplasm can be highlighted. Clearly, the treaty cannot be enforced if parties and signatories allow their seed companies and other breeders to use in-trust germplasm in secret. Further, it should be reiterated that agrofuel use of in-trust germplasm is subject to the ITPGRFA as an agricultural use of the genetic resources.

4. Place pressure on the agrofuel industry, through letters and public demands, to fully reveal the germplasm that is being utilized in its breeding programs. This should include genebank accession numbers, countries of origin, parentage of plants used, and all other types of data that will facilitate identification of sorghums being used and resolve informed consent and benefit sharing issues.

From the standpoint of social justice and food security, sorghum agrofuels hold little promise for Africa. They promote an industrialized agricultural model that is incompatible with much of rural Africa and its socioeconomic needs, as well as the capacity of local capital (for biorefining and distribution). Agrofuels further threaten to damage food security for both rural and urban Africans by their effect on food prices and potential to displace local food production.

Yet ultimately, whether Africa adopts agrofuel technologies or not, commercial interests in other regions are using African sorghum seeds to develop their own agrofuel industries. This ironic reality, linked to the legacy of colonialism, demands African attention in order to prevent unjust appropriation of African resources and to ensure that Africa exercises sovereignty over her own resources to promote appropriate rural development.

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