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Sorghum and the Antioxidant Craze: What Benefit for Africa's Farmers?

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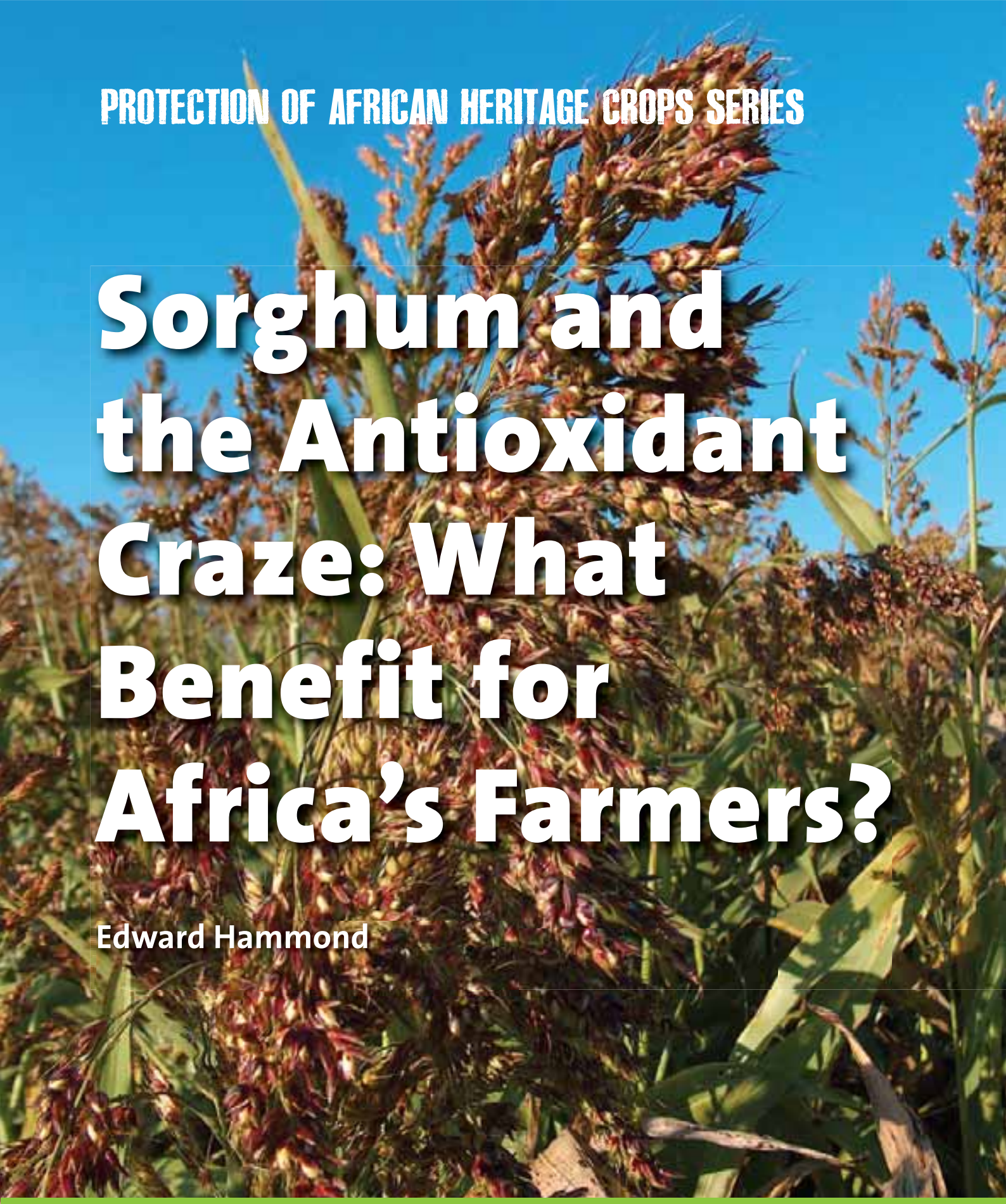

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Introduction

A highly successful health food company in the United States, Silver Plate Inc, is seeking to cash in on the health benefits of sorghum. More particularly, it has begun to commercialize foods rich in sorghum anthocyanins, natural "antioxidant" chemicals found in some strongly coloured plant foods that are believed to have heart and other health benefits.

Unlike many major cereal crops, high antioxidant genetic traits are readily available to sorghum breeders. This is because of the work of generations of African farmers, who selected and bred coloured sorghums for various purposes, including dyes for fabric, making food crops resistant to depredation by birds and disease resistance.

The owners of Silver Palate have a successful track record in the health foods sector. In 2007, they sold one of their companies, which makes fat-free imitation butter, for US $490 million.[1] Now, these same entrepreneurs are interested in sorghum. They have entered into agreements with major US supermarket chains to sell sorghum products, including breakfast cereals, baking mixes and crackers.

http://upload.wikimedia.org/wikipedia/commons/4/4d/Sorghum_bicolor_Bild0902.jpg

Silver Palate is negotiating to gain rights to sorghum varieties held by Texas Agricultural & Mechanical University (Texas A&M), from its enormous collection belonging to African farmers. Although it is a public university, Texas A&M is highly proprietary in its approach to seeds. It considers the vast majority of the thousands of farmers' varieties of sorghum that it possesses, and the breeding lines into which it puts African genes, to be proprietary.

Texas A&M is working to turn its sorghum collection into a university and personal profit centre. It is demanding fees and royalties from Silver Palate in return for access to African-derived sorghum seeds. Two thirds of the income will be allocated toward the cost of maintaining intellectual property claims and paid as personal profit to a Texas A&M plant breeder. The University is making no plans, and feels it has no moral or legal obligation, to share any benefits from the deal with African farmers.

Sorghum and the "antioxidant" craze

Sorghum is an important part of the human diet in a large part of Africa and other parts of the world, including South Asia. It is also used to produce alcoholic drinks including beer (Africa) and liquor (China). In developed countries, sorghum is generally grown for animal feed and other non-food uses (including agrofuels) and is less often consumed by humans.

Entrepreneurs in developed countries, however, are seeking to increase sorghum's popularity as a health food for people. This includes sorghum foods for people intolerant of glutens found in wheat and other cereals (Celiac disease), a problem for approximately 1% of the population of Europe and the United States[2] and whose incidence is rising.

Sorghum promoters, including Silver Palate, are seeking to build on keen interest from US consumers in "antioxidants" to counteract the effects of a high fat diet, such as clogged arteries and heart and digestive tract diseases. A major source of antioxidants in food are anthocyanins, natural pigments found in some plants. Anthocyanin antioxidants are associated with strongly coloured fresh fruits, such as blueberries, red and black grapes, and cherries, as well as derived products including juices and red wine. Some of these foods have recently enjoyed booming sales in the US because of claims about their healthful properties.

Sorghum anthocyanins in general

Anthocyanins analogous to those in fresh fruits are found in some sorghum varieties. Most sorghums that are widely cultivated in developed countries have no appreciable antioxidant content, but others, generally richly coloured varieties, have high levels of antioxidants. Ironically, developed country plant breeders have more often than not tried to remove anthocyanins from commercial grain sorghum varieties for many years, due to the bitter taste of some coloured sorghums and a preference for white coloured grain in some markets.

From the standpoint of antioxidant health claims, the notable anthocyanins found in sorghum are luteolinidin, an orange coloured pigment, and apigeninidin, a pigment described as either yellow or red.[3] Both of these belong to a group called 3-deoxyanthocyanins, which are found in ferns and mosses; but which are relatively rare in high quantities in edible plants (purple maize and some yams also have 3-deoxyanthocyanins).

Because luteolinidin and apigeninidin occur in combination with each other and with other pigments, the colour of a sorghum plant does not necessarily indicate its level of particular anthocyanins. Grain types of sorghum may have coloration of their seed and/or pericarp that varies from light tan through dark red to brown and then black. Coloration also may occur in different mixtures in different parts of the plant – edible and inedible parts.

Sorghum anthocyanins in farmers' varieties

Sorghum anthocyanins are not accidental components of farmers' varieties of sorghum and were not created by Northern plant breeders. They have been nurtured and developed by African farmers. There are three major reasons why African farmers selected sorghums for anthocyanin content. These are: 1) for use as dye; 2) to repel birds and thereby prevent crop loss and 3) plant disease resistance.

"Dyer's sorghum" produces vegetation with a deep red colour. It is primarily grown in West Africa and the Sahel. The red (or brown) in dyer's sorghum primarily comes from apigeninidin. In addition to colouring textiles, there are many other reasons African farmers created dyer's sorghum varieties. In Benin, for example, it is grown by small farmers for local markets, where the extracted dye "*is used as bio-colorant for foods (e.g. local cheese, porridge) and as body paint,* [to mark salt] *lick stones for cattle,*

leather, wickerwork, and ornamental calabashes. The dye is also used in traditional medicine to produce a red infusion that is believed to correct anaemia."[4]

Outside Africa, purified apigeninidin is also used as a fabric dye and in food industries. There is limited commercial cultivation in France, apparently of seed introduced from West Africa through *Institut de recherche pour le développement* (IRD), France's international agricultural development agency.[5]

Bird resistant sorghum, a type of "high tannin" sorghum, was developed and is widely cultivated in Africa. These sorghums have anthocyanins in their pericarp (called "bran" in the food industry) and/or grain. These kinds of sorghum are frequently used in brewing in Southern Africa. The anthocyanins that colour these sorghums yellow, tan, red, bronze, brown, and black have a bitter taste that discourages birds from feeding on them. This obviously increases the chances of the farmers' success.

http://de.academic.ru/pictures/dewiki/115/sorghum_bicolor02.jpg

Some bird-resistant sorghum varieties have been developed for areas of the United States with bird depredation problems. However, the higher tannin content of these types limits their digestibility for livestock, so their adoption has not been widespread.

Coloured sorghum was also developed by African farmers for disease resistance, particularly against anthracnose (a fungus) and grain moulds that can easily ruin a crop for human and animal consumption alike. "Red" sorghums are noted for their fungal resistance.[6] So much so that they have even attracted researchers from outside the agricultural arena, who have investigated sorghum apigeninidin as a potential antifungal and antimicrobial compound.

Texas A&M and Sorghum
Texas A&M is a leader among the small number of sorghum research centres in the United States. Others include Kansas State University, Perdue University and the company DuPont. Most US sorghum is grown in the "high plains" of the south central US, including parts of Texas. The US sorghum seed industry, which also exports seed, is concentrated in the "panhandle" region of north Texas. US sorghum breeders also operate winter sorghum nurseries in Mexico and the Caribbean – especially Puerto Rico.

Texas A&M's sorghum seed collection is perhaps the largest in the United States. It and the (freely distributed) US Department of Agriculture collection rival the collection of International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT), the international agricultural research centre that focuses on sorghum.

Texas A&M has amassed its sorghum collection, including tropical seeds, through decades of participation in missions to collect, screen, and adapt foreign sorghum seeds to US conditions. Beginning in the 1950s, Texas A&M's Sorghum Conversion Program collaborated with the US Department of Agriculture (USDA) to introduce valuable African sorghums to the US.[7] These were often collected under the auspices of the Rockefeller Foundation and many of these very same original collections went on to become part of the core collection of ICRISAT.

Today, Texas A&M continues to obtain new African and other seeds by participating in the International Sorghum and Millet Collaborative Research Support Program (INTSORMIL), sponsored by the US Agency for International Development (USAID). INTSORMIL styles itself as charity for Africa, but according to INTSORMIL's own studies, the US sorghum industry is its primary beneficiary. INTSORMIL estimates that sorghum germplasm that it has brought into the United States contributes at least US $680 million per year to the US economy. From 1996 to 2005, Texas A&M turned over 213 sorghum breeding lines developed from INTSORMIL germplasm to private US corporations. More than half of the commercial sorghum cultivars in the US have INTSORMIL parents.[8]

Texas A&M, along with the USDA and the Brazilian research agency Embrapa, is a co-owner of controversial US and international patent applications on a gene taken from a Tanzanian farmers variety of sorghum. The gene makes sorghum plants more productive in soils with high levels of aluminium.[9]

Sorghum anthocyanins at Texas A&M

Texas A&M professors are keen on the potential value of sorghum anthocyanins and have studied them with a view to profit from the health food market since the early 2000s. They have screened varieties for their anthocyanin content, focusing on identifying types that concentrate 3-deoxyanthocyanins in their seed coat, and on characterizing those anthocyanins.[10,11,12,13,14] They have also studied extraction of anthocyanins[15] and sorghum milling to identify efficient methods to separate bran from seed,[16] allowing bran to be sold for use in health foods and the remainder kept for other purposes.

Texas A&M publications indicate that it has identified two varieties that contain the highest levels of 3-deoxyanthocyanins. These are called Tx430 and "Black PI Tall". Both varieties have black coloured bran and are sometimes called "black sorghums".

Tx430 was officially released by Texas A&M in 1984. It is a cross of two seeds called SC170 and Tx2536. SC170 is an Ethiopian sorghum held in-trust under the Plant Treaty by ICRISAT, whose designation for the accession is IS 12661. Tx2536 is an older combination of Nigerian (Kaura) and Sudanese (Feterita) sorghums. Tx430 was developed by a former Texas A&M professor, who now works for MMR Genetics, a sorghum breeding company allied with Monsanto.

Texas A&M's chief sorghum breeder has refused to answer queries about the origin of "Black PI Tall" sorghum. While the seed is mentioned in several Texas A&M publications, it does not appear to have a published pedigree or be recorded in any online sorghum collection databases.

In its effort to draw attention to high anthocyanin sorghums, Texas A&M has developed promotional material for the food industry calling sorghum a "superhealthfood" [sic].[17] This promotion is so enthusiastic that some health claims made, appear to go beyond what has been conclusively proven by science. Texas A&M suggests sorghum can prevent colon cancer, make the overweight thin again, and improve diabetes.

Texas A&M actively promotes the African origin of its anthocyanin traits, claiming "*Incorporating exotic genes into sorghum has provided a varied array of special health sorghums for use in foods, feeds, and phytochemicals.*"[18] (In US sorghum breeding, "exotic" means germplasm newly introduced to the United States, generally from tropical and most often African sources.)

Although the Ethiopian SC170 and the secret "Black PI Tall" have so far yielded the most useful anthocyanins in published studies, Texas A&M claims to have even better sorghum varieties for health foods. Some are "black" sorghums, while others are yellow in colour, presumably from high apigeninidin concentrations. These may use the same African anthocyanin gene sources as Tx430 and "Black PI Tall", or could be different ones.

While admitting that it is taking coloured sorghum traits from African seed, Texas A&M has not described its other high 3-deoxyanthocyanin varieties, as it considers them proprietary and secret Texas A&M intellectual property.

Texas A&M's Intellectual Property Claims

For anthocyanin sorghums, Texas A&M's intellectual property assertions are currently based on the claims that the identity of most materials used in its sorghum breeding program are a "trade secret". Texas A&M will not identify the seeds it is using, contending that it has the legal right to keep this information secret because these plants may be sold and generate income.[19]

In the distorted reasoning of Texas A&M intellectual property policy (like many US universities), this secrecy benefits the public because it increases the likelihood that Texas A&M, a public university, will be paid for its African sorghum. This policy defines the vast majority of the sorghum seed that Texas A&M possesses as self-created, even though this is plainly untrue.

Ironically, even though Texas A&M's policies conveniently disguise appropriation of African germplasm in the name of protecting the US public interest, the income that Texas A&M derives from selling sorghum seeds has no public benefit for Americans either. None of the potential revenue from a license of high anthocyanin sorghum is planned to go to the University's public teaching mission.

http://upload.wikimedia.org/wikipedia/commons/8/84/Sorghum_bicoloro3.jpg

The University's internal arrangements stipulate that 37.5% of A&M's income is paid as a personal royalty to the professor that breeds high anthocyanin sorghum. A quarter (25%) of A&M's income is allocated for the cost of intellectual property claims, and the remaining 37.5% goes to support more proprietary sorghum research by the same plant breeder. None of the income is allocated to support the University's public education programmes in the US, much less any benefit for the African farmers who developed the key sorghum anthocyanin traits.

Texas A&M does not currently appear to have lodged any utility patent or plant variety protection applications for high anthocyanin sorghums.[20] However, it is highly likely that it will do so upon successful completion of a licensing agreement with Silver Palate or another company. Texas A&M's internal distribution of income from plant variety licenses includes a full 25% set aside to pay the cost of such intellectual property claims. If Texas A&M chose to pursue such claims in Africa, it could restrict use of some sorghum germplasm on the continent. However, until such claims materialize, the primary concerns are those relating to the injustice of Texas A&M and its partners exploiting "proprietary" African seeds for their own profit.

Negotiations with Silver Palate[21]

Texas A&M has been in protracted sorghum seed negotiations with Silver Palate, which is based in New Jersey. Silver Palate wants access to Texas A&M's seed varieties because Texas A&M reputedly has sorghum types that have higher levels of 3-deoxyanthocyanins than any commercially available sorghum varieties.

Negotiations have been slow, however, because the two sides have not been able to come to agreement on financial terms. Silver Palate wants more extensive rights to seeds than Texas A&M is prepared to give and there is disagreement on payments.[22] Texas A&M has asked for 3% of all product sales – and no less than $200,000 per year – to grant Silver Palate a license to yellow and black grain sorghum varieties with African antioxidant traits. If the products are successful, Texas A&M could quickly earn millions of dollars per year.

Although negotiations have been slow, Texas A&M confirms that it has recently executed a non-disclosure agreement with Silver Palate and that the two are aiming to agree on a license for the

African sorghums.[23] Under the non-disclosure agreement, Texas A&M will provide Silver Palate with more information about its high anthocyanin sorghum. This information reveals details about how Texas A&M is appropriating African farmers' seeds; but the Texas A&M will not release this to the public because it says it is proprietary.

In the Marketplace

Silver Palate has recently launched its sorghum product line, consisting of an initial selection of seven products: breakfast cereals, muffin mixes and crackers. The products incorporate high anthocyanin sorghum bran from a sorghum variety produced by a company called Sorghum Partners (owned by Chromatin, a Chicago-based company). Silver Palate is seeking to replace the Sorghum Partners variety with Texas A&M seeds.

http://www.worldpantry.com/cgi-bin/ncommerce3/ProductDisplay?prmenbr=127573&prrfnbr=4195535

The products are sold under the brand name "Grain Berry". The name is a play on the fact that American consumers associate berries with high anthocyanins, so it suggests that by eating this special grain (sorghum), people will enjoy the health benefits they associate with raspberries, blueberries and similar fruits. Company advertising touts the sorghum's "antioxidant" properties and pictures black, red, and other coloured sorghum seed heads.

Silver Palate sells the products through its own website at about US $5 per box (see endnote), emphasizing that the sorghum is "grown in the USA".[24] Silver Palate reaches a much bigger market through agreements with US grocery chains to stock the products on their shelves. These include Kroger, a large chain which operates nearly 2,500 US grocery stores,[25] and the luxury grocer Whole Foods, which claims to be the "*world's largest retailer of natural and organic foods*". Nicknamed "Whole Paycheck" due to high prices, the chain's 270 stores target wealthy consumers in the US, Canada, and UK. (Whole Foods also styles itself as a backer of sustainable agriculture and development, through support of organic farming and microcredit programs.)[26]

Silver Palate is a privately held company and no figures on "Grain Berry" sales are available. If "Grain Berry" is successful, it is reasonable to presume that other companies will move to offer high anthocyanin sorghum bran products.

Conclusion

African coloured sorghums are poised to earn profits for Texas A&M and the already hyper-wealthy businessmen of Silver Palate. The characteristics that differentiate Silver Palate's sorghum products in the market place are traits that were developed by African farmers.

These traits are being freely appropriated by Texas A&M, which considers African coloured sorghum genes and varieties that incorporate them to be proprietary. The public university believes that it has no moral or legal obligation to the African sources of its "proprietary" seeds. There is no indication in the extensive negotiation records obtained under the Texas Public Information Act that Silver Palate feels any responsibility either.

Texas A&M is attempting to maintain a wall of secrecy about the exact sources of its high 3-deoxyanthocyanin varieties, however, it is known that one of these varieties derives its key traits from an Ethiopian farmers' variety that has been declared in-trust under the Plant Treaty by ICRISAT (but which was obtained by Texas A&M prior to the Treaty).

All players in this business deal have the expectation of being substantially remunerated, an expectation that they regard as natural. From the Texas A&M plant breeder, who receives a whopping 37.5% of A&M's income from the sorghum, to the rich businessmen at Silver Palate and the high dollar Whole Foods Market, many of whose customers could spend a year or more of an African sorghum farmer's income in a single visit to the supermarket!

Not only do the players in "Grain Berry" view their profits as normal and natural, most also view themselves as being the "good guys" – from Texas A&M, which sees itself as promoting a neglected crop and public research (even though it considers all the outputs private!) to Silver Palate, which believes it is convincing Americans to eat more healthily, to Whole Foods, which believes that it is a supporter of sustainable agriculture and development.

Whether or not "Grain Berry" will make a dent in American's expanding waistlines and diet-related disease burden remains to be seen. What none of the institutions that are part of this business has on its mind, however, is the injustice of profiting and exploiting plant traits developed by African farmers, without even scant benefits for Africa, much less prior consent and mutually-agreed sharing of benefits.

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6 Bandyopadhyay R et al (2002). Sorghum Grain Mold: Through the 1990s into the New Millennium, chapter in Leslie JF (ed.) **Sorghum and Millets Diseases**. Blackwell / Iowa State Press.

7 Most tropical-origin sorghum is photoperiod sensitive and will not mature and set seed during long day conditions of high latitude summers. Thus, these seeds must be "converted" by crossing them with a photoperiod insensitive line and then breeding the resulting plant back to the original tropical parent (usually for several generations). The resulting "converted" germplasm (often also incorporating dwarf genes) will set seed in the far north or south yet retain the valuable traits of its "exotic" parent. Indeed, the objective is to create "converted" seed that is as true to its African parent as possible.

8 INTSORMIL. 2006. International Expertise Benefits U.S. Sorghum and Pearl Millet Producers. INTSORMIL Report No. 4, 1 August 2006.

9 See Hammond E (2009). Africa's Granary Plundered. African Center for Biosafety, December.

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18 Ibid.

19 These assertions have been made by Texas A&M in the course of numerous requests under the Texas Public Information Act. Much of the correspondence related to these requests (and all records released) may be viewed online at: http://www.pricklyresearch.com/AutoIndex/index.php?dir=TAMU_Sorghum/

20 There is a delay of at least six months, and quite often longer, after submission of patent applications before they are published. It is thus possible that patent applications exist; but have not been published at time of writing.

21 Except where otherwise noted, details of the negotiations between Texas A&M and Silver Palate were obtained in a series of Texas Public Information Act requests to Texas A&M University. All source materials are available at: http://www.pricklyresearch.com/AutoIndex/index.php?dir=TAMU_Sorghum/

22 Silver Palate has also proposed, as part of the licensing arrangement, to make some payments to Texas A&M through a tax-exempt foundation controlled by the company, in effect paying a business expense with a charitable contribution of tax-free dollars. Such a quid pro quo is of questionable legality in the US.

23 McCutchen, B (2010). Personal Communication. 1 November. (McCutchen is the Associate Director of Texas Agrilife Research, the relevant component of Texas A&M.)

24 Silver Palate's online store for sorghum foods can be viewed here: http://www.worldpantry.com/cgi-bin/ncommerce3/CategoryDisplay?cgmenbr=127573&cgrfnbr=4180079 (accessed 8 November 2010).

25 Kroger Company (2010). Operations Overview (website). URL: http://www.thekrogerco.com/operations/operations.htm (accessed 8 November 2010).

26 Whole Foods Market (2010). About Whole Foods Market (website). URL: http://www.wholefoodsmarket.com/company/index.php (accessed 8 November 2010).