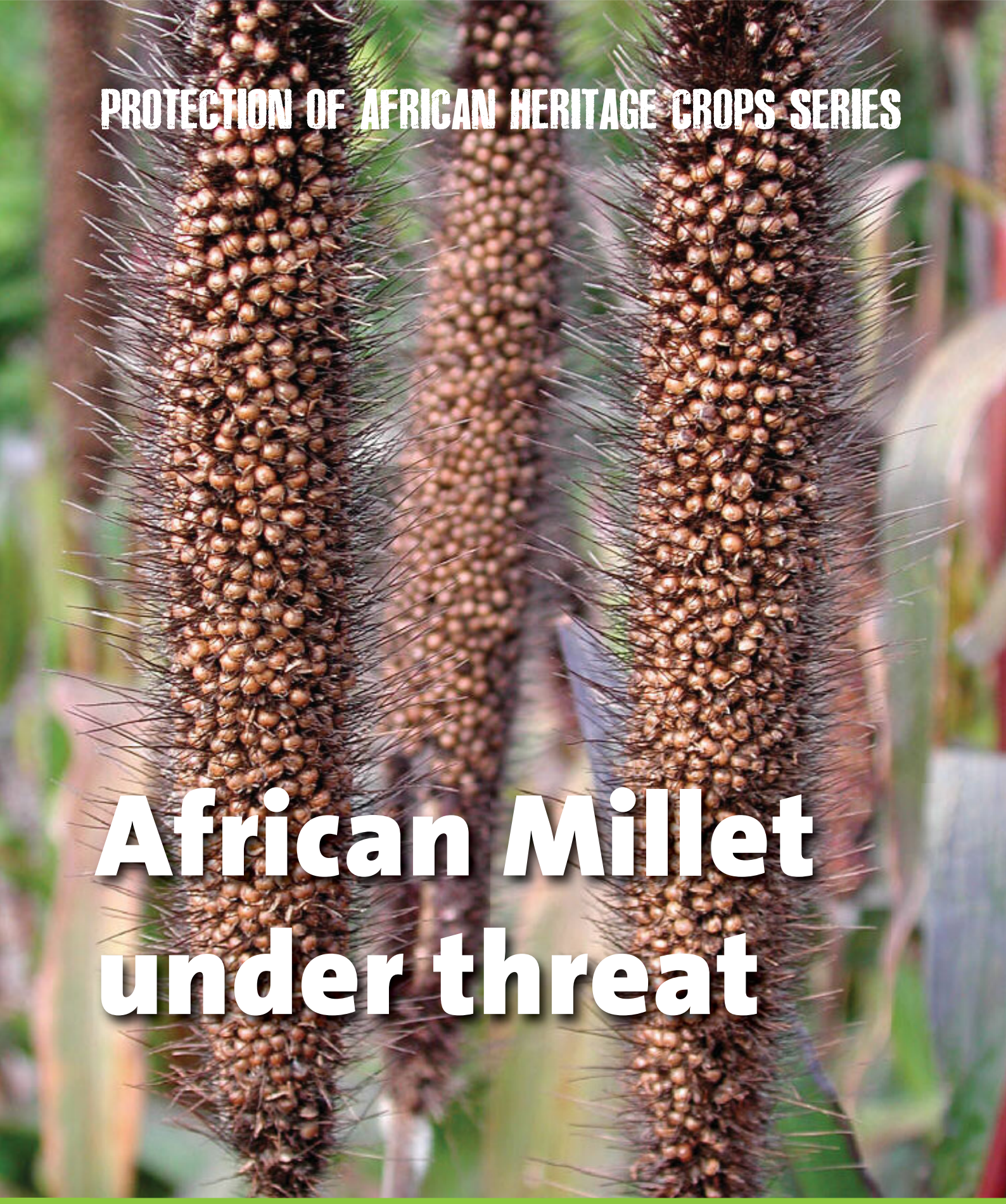
PROTECTION OF AFRICAN HERITAGE CROPS SERIES



African Millet under threat

african centre for biosafety
www.biosafetyafrica.net

Contents

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

Cover photo : https://facultystaff.richmond.edu/~jhayden/landscape_plants/ornamental_grasses/pennisetum_glaucum_%27jester%27_LGBG_02s.JPG

Acronyms

ACB	African Centre for Biosafety
ARCAD	Agropolis Resource Centre for Crop Conservation, Adaptation and Diversity
CGIAR	Consultative Group on International Agricultural Research
EMBRAPA	*Empresa Brasileira de Pesquisa Agropecuária*
ICRISAT	International Crops Research Institute for the Semi-Arid-Tropics
ILRI	International Livestock Research Institute
INTSORMIL	US International Sorghum and Millet Collaborative Research Support Program
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
SANBI	South African National Biodiversity Institute
SINGER	CGIAR System-wide Information Network for Genetic Resources
USAID	US Agency for International Development
USDA	US Department of Agriculture

Introduction

The African Centre for Biosafety (ACB) has focused several recent reports on new international commercial interest and patent claims on the African native crop sorghum. This includes the issues raised by the proposed widespread use of sorghum for the production of agrofuels.

This report extends ACB's examination of new international commercial interest in African native crops, by including a focus on pearl millet (*Pennisetum glaucum*) and related African native grass species in the *Pennisetum* genus.[i]

Globally, pearl millet is less widely sown than sorghum, yet it is a key food and feed crop in arid and semi-arid parts of Africa and Asia (particularly India). Pearl millet occupies smaller but significant markets in the US, Europe, and elsewhere, where it is mainly grown for animal feed and forage. In the US, for example, pearl millet is grown on about 600,000 hectares each year. To a lesser extent, it is also grown outside Africa for human food.

Other African pennisetums, such as Napiergrass, are also economically important outside Africa. They are sold in the lucrative landscape plant markets, as lawn grasses, and as feed and forage for the bird and exotic game hunting industries.[1] In the United States, recent interest in African pennisetums as landscape plants has led to a variety of new patent claims.

Like sorghum, one reason pearl millet is of interest to these markets, is its' tolerance of dry, even desert-like conditions, and of low fertility soils. These characteristics are likely to be increasingly important in Africa and elsewhere as a result of climate change. Pearl millet is typically inexpensive to grow and may be sown on land where more water-intensive plants, like maize, would perish without irrigation. These advantages have stimulated interest in the use of millet to produce ethanol for agrofuels from grain. There is a further interest in use other pennisetum species to produce agrofuels from plant biomass.

i. Millet is a collective term that can refer to several different grain crop species, including pearl millet (P. glaucum), finger millet (Eleusine coracana), fonio (Digitaria spp.), and teff (Eragrostis tef). This report only covers pearl millet along with other African species that are also members of the Pennisetum genus.

African Pennisetums

Pennisetums are a genus of tropical and warm temperate grasses found in many parts of the world. While there are pennisetums native to Asia, the Middle East and the Americas, it is the native African species that are globally more important from an economic and food security perspective.

The most important is *Pennisetum glaucum*, or pearl millet, a staple food in the Sahel and other parts of Africa. Outside the continent, pearl millet is an important source of food in India.It is also grown for animal feed and to a lesser extent human food, in other world regions. Like sorghum, pearl millet is a crop that has not been prioritized by formal science but has attracted attention because of its perceived advantages in coping with climate change – most notably its drought tolerance.

Pearl millet is certainly not the only African pennisetum of international importance. Other pennisetums are cultivated for feed and ornamental purposes. These include *P. purpureum*, or Napiergrass (Uganda Grass), which is important for livestock in Africa and elsewhere. *P. setaceum*, or fountain grass, and *P. villosum*, or feathertop grass, are popular ornamental plants.[2] For lawns and grazing, Kikuyu grass (*P. clandestinum*) is another African native sown on the continent and elsewhere.

Pennisetums share the highly efficient C4 photosynthesis pathway. This makes them suitable candidates for plant improvement programs. In some places, however, their adaptation to heat and rapid growth has caused them to come to be considered invasive weeds.[3]

The major international collection of pearl millet germplasm is held by the International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) in Patancheru, India. ICIRSAT is part of the international Consultative Group on International Agricultural Research (CGIAR) system. Pearl millet, genus *pennisetum*, is listed as a food crop in Annex 1 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), thus, pearl millet germplasm falls under the multilateral system of benefit sharing established under the treaty.[4]

African Countries of Origin of Pearl Millets in the ICRISAT Collection[5]

Nigeria	2065
Zimbabwe	1384
Niger	1132
Namibia	1118
Mali	1048
Cameroon	911
Burkina Faso	860
Sudan	587
Togo	520
Tanzania	478
Other West Africa	804
Other East Africa	520
Other Southern Africa	430
Other Central Africa	258
Other North Africa	15

CGIAR's plant germplasm database (SINGER) indicates a further 244 forage pennisetum accessions are held by the Nairobi-based International Livestock Research Institute (ILRI). ILRI's forage research is concentrated at its campus in Addis Ababa. It is unclear, and appears unlikely, that the 244 accessions listed in SINGER reflect the entirety of ILRI's pennisetum collection. Almost all of those that are listed are African (many others are from Yemen).

The following pages examine commercially-oriented research on African pennisetums, beginning with the ornamental and landscape plant sector, where pennisetums several recent intellectual property claims have been lodged.

Proprietary Pennisetums in the Landscape Market

Crop genetic resources discussion frequently focuses on plants for food and feed uses. Ornamental and landscape plants, however, are an enormous economic market, especially in developed countries. In 2009, in Germany, for example, *retail* sales of ornamental plants totalled € 8.6 billion.[6] In the US, in the same year, the *wholesale* value of domestically produced ornamental plants (excluding cut flowers and greens) was over US $3.25 billion.[7]

Pennisetums are growing in popularity as ornamental plants in the US and Europe. In warmer regions, they can be grown as perennials. In colder areas, they are grown as annuals or in containers that are sheltered from freezing winter conditions. In part, pennisetums are becoming more popular because of their relatively low maintenance and water requirements.

The greatest attraction for the ornamental plant industry has been the release of a number of brightly-coloured, mainly proprietary, African pennisetums. These have a striking appearance in urban and suburban yards. Many of these plants, some of which are hybrids of different pennisetum species, are reproduced from cuttings or root divisions, and not seed.

Where did these plants come from? An analysis of a breeding program at the University of Georgia in the United States gives insight as to how African germplasm relates to the ornamental pennisetum market,. This program holds six US plant patents and patent applications on ornamental pennisetum varieties.

PEARL MILLET (*PENNISETUM GLAUCUM*)
http://upload.wikimedia.org/wikipedia/commons/4/4d/Sorghum_bicolor_Bild0902.jpg

It is clear that pennisetum seed from Africa is key to these patented varieties; but elucidating its exact role is hampered by inadequate pedigrees and plant descriptions supplied by breeders. (For example, plant pedigrees that rely on parent plants identified only by internal breeding program designations that are not themselves published or otherwise explained.)

The University of Georgia's Pennisetum Program

The University of Georgia's current pennisetum patents are for "Tift-23" and "Tift-17", both inter-specific combinations of pennisetums, and "Prince" and "Princess", both purple-coloured napiergrasses. It also has patent applications pending for "Princess Molly"[8] and "Princess Caroline",[9] smaller versions of "Prince" and "Princess", respectively. The names reflect the "inventor's" view that the plants have a regal visual aspect. The key trait that sets them apart as ornamental plants is their colour, varyingly described as purple or red.

The University of Georgia's four princely patents and patent applications are all selections of a napiergrass designated "Anae Roxo CNPGL". This grass was provided to the University of Georgia in 1996 by Brazil's national agricultural research agency, *Empresa Brasileira de Pesquisa Agropecuária* (EMBRAPA).[10]

PEARL MILLET (*PENNISETUM GLAUCUM*)
http://test1.icrisat.org/ESA/region_clip_image002_0005.jpg

Several deductions can be made about Anae Roxo CNPGL from its name. The grass came from EMBRAPA's *Centro Nacional de Pesquisa de Gado de Leite in Minas Gerais*. Formerly called CNPGL, it now refers to itself as EMBRAPA *Gado de Leite*. It is the Brazilian government centre for research on cattle (*gado*) and milk (*leite*) production. EMBRAPA *Gado de Leite* has a research program on forage resources that maintain a forage species germplasm collection,[11] and which is presumably the source of the napiergrass provided to the University of Georgia.

It is also clear that Anae Roxo CNPGL already has its red/purple traits when it was sent to the US, as "roxo" simply means "red".

Georgia's patent documents state that the inventors simply selected red plants of their liking among Anae Roxo CNPGL seedlings. They decided to call the colour purple, bred the selections to themselves and further selected for plant height. The desired colour and (shorter) stature was achieved in only about three generations. In June 2005, they filed patent applications on Prince (semi-dwarf) and Princess (dwarf). These were granted in 2008 as US plant patents 17,728 (Princess) and 18,509 (Prince).

While the EMBRAPA napiergrass is ultimately of African origin, the University of Georgia has never published any meaningful passport or characterization information about Anae Roxo CNPGL, nor was it required to do so in order to obtain the plant patents. It does not appear that EMBRAPA has published any characterization information about Anae Roxo CNPGL either. It is not known if EMBRAPA merely provided the variety to the University of Georgia after receiving it from an African source, or if the napiergrass was bred at EMBRAPA.

The meaning of word "Anae" in the napiergrass name is unclear. The only "Anae" that can be associated with napiergrass research is ANAE, a Malagasy NGO that since at least the 1990s has worked with international agricultural research groups (notably France's CIRAD and American USAID[12]) on agroecology projects. This includes CIRAD-funded work with napiergrass in Madagascar that is in part overseen by Brazil-based CIRAD employees.[13]

Based on published information, however, the link between Madagascar and the University of Georgia's patents remains conjectural.

The University of Georgia's other claims on pennisetums are for Tift-23, a cross between pearl millet and napiergrass, and Tift-17, a three way cross between pearl millet, napiergrass, and *Pennisetum squamulatum*, another African species.

The patent documents for Tift-23 and Tift-17 shed some light on their origin, which has been supplemented by discussions with the University of Georgia. While not particularly complex to a plant breeder, the origin of Tift-23 and Tift-17 can be hard to understand because of confusing names and the odd science involved in crossing species with different chromosome numbers (e.g., there are several different plants that Georgia refers to as "Tift-23", even though they are genetically distinct).

To summarize, however, Tift-23 yet again utilizes Anae Roxo CNPGL napiergrass as a female parent, and a red coloured pearl millet is the male parent. Tift-17's parentage includes the same red coloured millet as Tift-23, plus a *P. squamulatum* collected in the Congo (Dem. Rep.) in 1958 and "Merkeron", an older variety of napiergrass selected in the US in the 1940s whose geographic origin is unrecorded.

PENNISETUM SETACEUM
http://stokestropicals.com/images/max_image/352-76.jpg

The University of Georgia repeatedly declined to elaborate on the origin of the red pearl millet parent of both Tift-17 and Tift-23. Georgia insists that the seed was described in a 1992 *Journal of Heredity* article. That article, however, simply states that the origin of the red seed is "unknown".[14]

Intense discussions with the University of Georgia and the "inventor", Wayne W. Hanna, also failed to yield further information about the origin of Anae Roxo CNPGL. As with the red pearl millet, the University and Hanna disavow any specific knowledge of where the EMBRAPA napiergrass came from.

The University of Georgia's pennisetums are enjoying commercial success. The varieties have been licensed to several private nurseries, which pay royalties to the University of Georgia.[15] These include Athens Select, Emerald Coast, Euro-American, and others.[16] The nurseries are privately owned and sales data is thus unavailable.

There are other pennisetums of African origin on the US ornamental market, including several patented coloured varieties of fountain grass (*P. setaceum*).

Ball Horticulture and the University of Nebraska Cash in on ICRISAT Pearl Millet

US patent 7,750,214, issued to the University of Nebraska and Chrysantis, Inc, of Chicago, Illinois (US) on 6 July 2010, claims "53-1-1", a pearl millet variety with a purple gene, its use in plant breeding and the resulting plant varieties. The claims include both pearl millet varieties bred from 53-1-1 as well as crosses with other plants, including hybrids with Napiergrass (*P. purpureum*).

Chrysantis is a phytonutrient subsidiary of Ball Horticultural, a family controlled private US company that is a major international producer of flower and vegetable seeds and plants. Ball's products stock the shelves of garden centres in the US and about 20 other countries worldwide. Its brands include PanAmerican Seed, Burpee, Darwin Perennials and Kieft Pro.

In South Africa, Ball both sells plants and has prospected for new ornamental plant varieties through an agreement with SANBI, the South African National Biodiversity Institute. From 2002 to 2006, Ball commercially released at least seven ornamental plant hybrids and varieties bred from South African native plants.[17]

Ball claims that the purple pearl millet plants are useful as ornamentals and as a source of anthocyanins (plant dyes). This is not a novel use – red and purple millets have traditionally been used for dyes in Africa.[18] Although not explicitly mentioned in the patent, given Chrysantis' focus on plant drugs, the company may also be assessing the human nutritional or drug value of millet anthocyanins, which may have "antioxidant" properties beneficial to heart health.[19]

53-1-1 follows "Purple Majesty", another ornamental pearl millet released in 2003 by the same breeder, the University of Nebraska's David Andrews. Purple Majesty was judged to be one of the most successful new ornamental introductions to the US in the 2000s.[20] It was licensed to Ball Horticultural, although it does not appear to ever have been patented. According to the recent patent, the difference between 53-1-1 and Purple Majesty is that the purple coloration gene in 53-1-1 produces a deeper colour.
As with the University of Georgia's pennisetum breeding program, unclear records make it difficult to identify the origins of the Ball and Nebraska's millet varieties. .

PENNISETUM VILLOSUM
http://www.cambridge2000.com/gallery/images/P8067854.jpg

What is known is that "Purple Majesty" and 53-1-1 are mainly (and perhaps entirely) derived from pearl millet varieties recently introduced to the US from ICRISAT. It is also clear that the purple coloration of the varieties is not the result of a lengthy breeding program to tease out and deepen purple traits, rather, the coloration genes were simply "discovered" in plants grown from the foreign seeds.

Specifically, the primary progenitor of both Purple Majesty and 53-1-1 is the ICRISAT accession IP 18293, whose pedigree is only partially recorded in publicly available documents. The parents of IP 18293 are a Sudanese millet, IP 10729, from east of El Fula in Kurdufan Province, and IP10399, an ICRISAT purple dwarf millet of unclear origin.[21] All three of the ICRISAT seeds (10729, 10399, and 18293) have been declared to be held in-trust under the Plant Treaty.

Andrews and the University of Nebraska were not researching ornamental plants when "Purple Majesty" was identified as a profitable ornamental plant.. IP 18293 was developed at ICRISAT for use

in disease resistance (downy mildew) research. This is why Nebraska obtained the accession. Indeed, Nebraska was conducting millet research for food and feed purposes with the sponsorship of the US Agency for International Development (USAID) and USDA's INTSORMIL program.[22] Purple Majesty and 53-1-1 provide a useful illustration of how the INTSORMIL "foreign aid" program can bring greater financial benefit to the US than to Africa.[23]

USDA's Mystery Agrofuel Program

Napiergrass, pearl millet and other African penniseums are also considered potential feedstocks for the production of ethanol agrofuel, a process that currently primarily relies on maize and, in warmer regions, sugarcane. Napiergrass in particular, which grows quickly and is high in biomass production is considered a viable alternative by some agrofuel promoters. It has been argued that Napiergrass could be among the most productive agrofuel crops for warm subtropical regions like the southern United States.

For this paper, ACB sought to investigate a napiergrass agrofuel research program that is a joint effort between the US Department of Agriculture (USDA) and the private sector. In the project, USDA is providing napiergrass varieties to companies and assisting them to further develop the crop as an ethanol source. This research is based at a USDA centre in Tifton, Georgia. (This is the same place that the University of Georgia researches pennisetums – USDA and the University of Georgia share resources and staff.)

However, ACB's request, under the US Freedom of Information Act, for information about the napiergrass agrofuel program was denied. ACB asked USDA to reconsider its position, but it again refused to release information. ACB has now presented a formal legal appeal, which is under consideration by USDA's leadership.

The reason for the secrecy around the napiergrass program is USDA's claim that all meaningful information about the research are trade secrets of the companies with which it is working (even though USDA publicly-funded scientists are providing the napiergrass varieties to the private sector).

USDA further refused to identify the companies it is cooperating with and to provide any information about the napiergrass plants that the program is using. USDA claims that all details of the research are trade secrets. This includes provisions of the financial agreement to share profits between USDA and the companies. In fact, USDA will not even release the title of the project to the public.[24]

US government secrecy thus makes it impossible to determine where the agrofuel napiergrasses come from, although chances are high that they have recent African parentage.

Despite USDA's denial of ACB's request, one USDA document available on the internet suggests that the research partners are two US companies that primarily contract with the Department of Defense, and that the napiergrass agrofuel project also includes environmental remediation goals,[25] a line of research also being pursued in Australia and China.[26]

Pearl Millet Research Projects Raise Questions

While there is a considerable amount of proprietary commercial interest in African pennisetums for ornamental and agrofuel purposes, the relatively small markets (except in India) for pearl millet

outside Africa have limited the attention that the crop has received from agro-industrial seed companies. Thus far, compared to crops such as maize, soya and rice, pearl millet is a minor crop in overseas markets. Commercialization of pearl millet seed within Africa is also limited because of farmers high level of reliance on traditional seed saving and sharing systems.

A number of international research projects are focused on pearl millet and have goals that could lead to changes for African millet farmers, including proprietary claims over pearl millets in Africa and overseas. For instance, ICRISAT, the international research centre in India, has developed new pearl millet hybridization systems. Although ICRISAT's focus mainly appears to be the Indian seed market, the US government's International Sorghum and Millet Collaborative Research Support Program (INTSORMIL) wants to use ICRISAT's research to create pearl millet hybrids for sale in Africa.

Meanwhile, the recently launched French government project ARCAD (Agropolis Resource Centre for Crop Conservation, Adaptation and Diversity) has placed early emphasis on pearl millet, with a view to understanding its adaptation to climate change and its genetic diversity in Africa.[27] The French project includes emphasis on identifying and helping African farmers preserve in-situ millet diversity. The data its studies generate (for example, identification of climate-related genes) could, however, fuel patent claims by companies.

The most ambitious project is INTSORMIL, the USAID and USDA "foreign aid" program that financially benefits the US more than Africa. INTSORMIL links US academic and African scientists who study pearl millet (and sorghum). The most recent project description of this program (2007), that ACB has obtained outlines its far-reaching projects, some of which raise concerns.

US Government Pearl Millet Research Goals (INTSORMIL Program) for Africa[28]

Goal	Description	Our Comments
Improved Pearl Millet Hybrids	Using ICRISAT-developed hybridization systems, "help" Africa transition away from open-pollinated pearl millet varieties by creating hybrids for sale in Africa.	May threaten traditional seed saving and sharing, and erode *in-situ* pearl millet diversity. Hybrids may not be appropriate for much of Africa – small farmers cannot afford bought seed, and distribution systems do not exist. Commercial seed systems may not be as resilient as traditional ones under climate, economic, or political stresses.
Greater Pest and Disease Resistance	Fight nematodes, striga, mildew, molds, and other problems by finding and adding resistance traits to new varieties.	Resistance traits mainly come from African farmers varieties. Although these traits could be more broadly used by African farmers, in the INSTSORMIL scheme, the main beneficiaries of (hybrid) seed with resistance traits may ultimately be companies, not the farmers who developed the traits.

Goal	Description	Our Comments
Incorporate "Market-Driven" Quality Traits	Breed pearl millet varieties for specific markets, such as preferred colour for consumers, for poultry feed, or for agrofuel ethanol production.	"Quality" means different things to different people. Traits under development may not lead to desirable outcomes for Africa. For instance, encouraging African farmers to use millet harvests for agrofuels and chicken feed may exacerbate food insecurity.
Collection and Evaluation of African Pearl Millet Farmers' Varieties	Through African collaborators, collect African farmers' varieties of pearl millet for evaluation and incorporation into US-based breeding programs.	While the US returns some seeds it breeds to Africa, it also keeps copies of every African seed that it takes. These are then distributed to US companies and other researchers. The US has not ratified the Plant Treaty, and it does not appear that African countries are using appropriate transfer agreements to prevent theft of these materials through future patent and other intellectual property claims.

A number of the of the issues raised by INTSORMIL's goals are similar to those facing other African crops that are maintained and developed by traditional methods in many countries, such as sorghum and African rice (*O. glaberrima*). How to introduce (or not introduce) hybrids, distribute new resistance traits, and adapt to changing markets all require a deliberate policy process. If African countries wish to protect traditional seed systems and their genetic diversity and food security benefits, they need to safeguard against defaulting to the American model

Distressingly INTSORMIL's ongoing provision of African farmer's varieties of pearl millet to US researchers in the apparent absence of appropriate safeguards threatens African farmers and sovereignty of African states.. The African varieties are provided to the US through a network of African institutions in Mali, Ghana, Nigeria, Burkina Faso, Niger, Senegal, Botswana, and Zambia, as well as on visits to Africa by US researchers.[29]

The US has not ratified the Plant Treaty and thus is not part of the international benefit sharing system for pearl millet seeds. Further, even if the US were to ratify the treaty, its provisions may not be applied when US non-governmental (e.g. academic) institutions collect seeds.

The US distributes the millets in its national collections without any restrictions on patenting or any requirements for benefits to be shared with Africa. No figures are available regarding the value of this pearl millet germplasm to the US economy, however, apart from India, Africa is the only major source of new pearl millet germplasm. By way of comparison, numbers are available for the benefits to the US from INTSORMIL sorghum. In 2006 it was estimated that INTSORMIL *sorghum* germplasm was worth $680 million per year to the US economy.

Thus, to the extent that pearl millet and other African pennisetum seeds are being transferred to the US without appropriate material transfer agreements, they are effectively being offered for patenting

by agro-industrial and other interests, with no obligation on the part of INTSORMIL or others to return any benefits to Africa.

While it is possible that some African institutions are using material transfer agreements to protect African interests, in the extensive set of INTSORMIL records that have been reviewed by ACB, at no time has any US-based researcher reported any difficulty or MTA requirement to obtain new African germplasm.
It therefore appears likely that the vast majority of pearl millet given to the US has been transferred with no restrictions that would prevent proprietary claims by private industry or academic researchers. In fact, several INTSORMIL academic researchers hold patents on millet and sorghum germplasm, including Nebraska's Andrews and Georgia's Hanna, both discussed in this paper. This should serve to remind African governments and scientists that it is dangerous to assume that US academics do not have commercial interests in plant research.

Ensuring Africa's sovereignty over one its most important crops, now and in the future, would appear to require the restructuring of its relationships with INTSORMIL and the use of appropriate material transfer agreements whenever African pennisetum germplasm is sent to the US.

Conclusion

Although modest in comparison to sorghum research, overseas commercial interest in African pennisetums is growing. In the ornamental plant industry, African pennisetums have been particularly successful in recent years, with the commercialization of a number of patented varieties that draw upon African farmers' seeds.

Fully understanding the recent African contribution to these commercialized ornamental plants, however, is hampered by the pitiable disclosure of plant pedigrees in patent documents and by breeders themselves. Similarly, efforts to understand the use of African Napiergrass varieties in a joint venture between the US government and private companies is being thwarted by the US government's refusal to release even basic information about the project.

Pearl millet, the most important African pennisetum economically and for food security, shows promise to foreign researchers for a variety of applications. A US government project working on pearl millet is seeking to stimulate development of the seed industry in Africa by replacing traditional varieties with commercial hybrids, and by creating pearl millets for specific uses including poultry feed and for agrofuels. These US goals may not be beneficial for African farmers, however, and African policymakers would do well to consider them carefully rather than accept the American corporate agenda.

Finally, the ongoing unchecked provision of African farmers' varieties of pearl millet to the US INTSORMIL project, without the use of appropriate material transfer agreements, is alarming. Over time this practice is likely to result in biopiracy. These seed transfers do not enjoy the protections and benefit sharing of the multilateral system under the ITPGRFA and African governments should move quickly to reassess their relationships with INTSORMIL and to ensure that seeds are not provided to INTSORMIL without adequate safeguards to prevent their theft.

References

1 In 2007, there were about 3,750 US private ranches breeding or hosting non-native large animals for hunting safaris. The state of Texas alone has about 250,000 head of "exotic" animals. African horned species, such as antelope, oryx, eland, and aoudad are favored. Adult males of larger species cost US $5,000 or more to hunt per head. Rights to shoot "super exotics" such as Roan antelope or bongo can fetch $25,000. The industry is estimated to be worth $1.3 billion per year.

2 *P. setaceum* should not be confused with *P. alopecuroides*, or Chinese fountain grass, which is also sold as an ornamental plant but which is not an African native.

3 For example in New South Wales (NSW), Australia, where *P. setaceum* is classified as a noxious weed. See NSW Primary Industries (2011). Weed Alert: Fountain grass (website). URL: http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/profiles/fountain-grass

4 Pennisetum is not listed among the forage crops in Annex 1, however, the Treaty's Article 12.3a, on purpose of access, may also come into play. Thus the applicability of the ITPGRFA to access and use of pennisetum germplasm in the multilateral system for non-food uses is, to this author, ambiguous.

5 Compiled from: Upadhyaya HD et al (2008). Augmenting the Pearl Millet Core Collection for Enhancing Germplasm Utilization in Crop Improvement. Crop Sci. 49:2. By ICRISAT's count, India is the single largest origin of pearl millet in the ICRISAT collection, however, that count (7,767 accessions) includes material bred at ICRISAT or which indicates ICRISAT as its origin for other reasons (e.g. country of origin unknown).

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14 Hanna WW and GW Burton (1992). Genetics of Red and Purple Plant Color in Pearl Millet. J. of Heredity 83(5).

15 University of Georgia Research Foundation Ledger Reports, obtained under the Georgia Open Records Act, 19 January 2011.

16 For example, the following wholesale websites can be consulted as examples of these plants for sale: Emerald Coast Growers: http://www.ecgrowers.com/Pennisetum-p-Princess-Caroline-38-p/2450.htm
Athens Select: http://www.athensselect.com/ASGrower_PennisetumPrincess.html

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