

IMPLICATION OF THE PAST 50 YEARS OF HYBRID SORGHUM RESEARCH TOWARDS FOOD SECURITY IN AFRICA

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Sorghum was first domesticated in Africa around 3000 B.C. Most of sorghum parents used in the USA were introduced from Africa in the 1870's. Today, the USA is the biggest producer of grain sorghum and productivity of sorghum increased more than 139% since 1950's. Many African countries produce sorghum but productivity per hectare is very low. In order to learn from what contributed to relatively high sorghum productivity in the USA and its implication to Africa, a research was initiated in Kansas State University with the following objectives: 1) to observe grain sorghum yield trends in dryland and irrigated agriculture for the past six decade in the USA, 2) to identify the specific contribution of the hybrid improvement program towards sorghum productivity in the USA, and 3) to identify the implication of the breeding program to African sorghum production. Yield performance test results from field experiments and greenhouse studies were used to answer these objectives. Yield performance tests indicate that there was an increasing trend in dryland sorghum hybrid performance while irrigated grain sorghum yields were almost constant for the past six decades. The question why there is an increase in dryland sorghum yield but not in irrigated was answered by the greenhouse study. The greenhouse study on representative hybrids from the last six decades shows that there was a 129% increase in root dry weight in new hybrids when compared to oldest. Leaf biomass was also increased substantially with advancement of hybrids over time. This shows that the result of hybrid development programs enabled an increase in resource use by creating hybrids with a better morphological character. This implies that main production constraint, water deficit, that hinder production in most sub-Saharan Africa can also be addressed with an intensive hybrid improvement programs which are geared towards finding hybrids that can have better resource use efficiency.

Assessment of the Potential for Elephant-based Ecotourism in Mali

Ted Cable

The Gourma region of Mali hosts the northern most population of elephants on the African continent. These animals, which have coexisted with humans for generations, are at a critical juncture, as competition for water and food resources increase with expanding human and livestock populations in the area. A team comprised of technical experts from US Forest Service, Kansas State University, and Association Malienne pour la Conservation de la Faune et de l'Environnement (AMCFE) worked in-country with counterparts from Mali's Direction Nationale de la Conservation de la Nature, important stakeholders, local, regional, and national government representatives, local and international NGO's, community associations, and travel agencies to assess the role that ecotourism might play in preserving this elephant population. The team visited key sites along the elephants' migratory path examined the feasibility of tourism in the area, and gained insights from local populations and governments. The team believes sustainable ecotourism in the Gourma Region is, indeed, a viable vector for conservation as well as improved livelihoods of local populations. The successful implementation of ecotourism in the Gourma Region will be dependent upon inter-ministerial collaboration between the Ministry

of Environment and Sanitation, Ministry of Tourism, and the Ministry of Culture, and transparent partnerships with other actors in the region.

Understanding Spatial Variability-Protocol for Measuring and Monitoring Soil Organic Carbon

H. Diop

Despite a long story on soil carbon studies and numerous recent technological advances, we still lack a comprehensive, quantitative understanding of soil C. This is in part due to methodical/methodological difficulties in measuring carbon spatial variability in soils. Because soil C measurement have been mostly investigated under laboratory conditions, the effective control at the field scale and the spatial variability of soil C on a landscape scale is still not satisfactorily clarified. Recent technological advances in measurements of soil C contents offer new opportunities in this area. Our objectives are to (1) evaluate the differences between field and laboratory measurements of different soil Characteristics such as total C, total N and bulk density, (2) production of spatially explicit maps of soil carbon for the different study areas under current conditions that can be used to scale-up site specific measurements to different ecosystems, regional and global scales. Toward these objectives this research will facilitate the sharing of recent methodological advances in soil C measurements and models. Enhance and facilitate research activities in under-sampled ecosystems and geographic regions.

A Spatial Database of Ethnoveterinary Medicinal Plant Use in and around the Greater Limpopo Transfrontier Conservation Area

Ronette Gehring

Locally available plant material is commonly used in traditional medical practices. The future sustainability of this important health system is highly dependent on the conservation and management of these natural resources. Important considerations in a resource management program are how levels and methods of plant harvesting and use correlate with species abundance, distribution, reproduction, and growth. This is also important information for assessing the impact of habitat destruction through urbanization, overuse and climate change, as well as changes in use driven by the migration of different cultural groups. An extensive literature search was conducted to compile a comprehensive inventory of medicinal plants documented to be used by communities living in and around the Greater Limpopo Transfrontier Conservation Area. The search yielded 21 references, in which 758 plants were documented to be used for the treatment of livestock and other animals. 1,996 different indigenous names were used to describe these plants and 30 different languages were spoken by the studied communities.

Soil microbial community responses to farm management strategies in Zambia*

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One of the major constraints to crop production in eastern Zambia is soil fertility. We are studying the effects of conservation farming strategies on soil quality and its relationship with crop yield in three agroecological zones: Mpika (Northern Province), Lundazi and Mambwe (Eastern Province). In our new study, we are evaluating soil microbial communities in the different farming systems. We are using pyrosequencing methods, which allow us to place hundreds of thousands of individual microbes in taxonomic categories. Our goal is to understand how microbial communities respond to the different crop management practices and, ultimately, how these communities may be managed for improved soil quality and crop productivity.

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The Segkwa Project: A Collaborative Research and Training Program in Savanna and Grassland Ecology

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Grass-dominated ecosystems cover approximately 1/3 of the Earth's surface and are the most extensive terrestrial ecosystem type in Africa. Worldwide, grasslands provide a myriad of essential ecosystem services and are the most important ecosystem type supporting human livelihoods. The Segkwa Project is a new multi-institution U.S.-Africa partnership launched by Kansas State University for international research and education focused on grass-dominated ecosystems. The Segkwa Project focuses on several key themes and questions concerning ecological processes in grasslands and savannas in the context of global environmental change. The key scientific goals of the project include: 1) Assessing the rates and trajectories of land use and land cover change in African savannas, 2) Developing appropriate GIS tools and data rescue programs to quantify environmental change at various scales, 3) Studying effects of global environmental change on biotic interactions and ecological processes, and 4) Assess patterns and ecological consequences of changes in biodiversity (declines in populations of native species and invasion of exotic species). The Segkwa project will implement a new model for student training and international education that focuses on peer-mentoring, a coupled international field course and student research experience, and strong collaboration and connectivity through use of modern video communication technologies. The aims of the Segkwa Project are to address important fundamental questions in ecology and global change biology, provide a needed scientific foundation for addressing environmental conservation and sustainability needs in Sub-Saharan Africa, provide globalized training of U.S. students, and build capacity among African institutions and land and resource managers.

Effects of sorghum variety on growth and carcass characteristics in broiler chicks reared in West Africa.

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A total of 840 1-d-old broiler chicks (Arbor line with an average body weight of 31 g) were used in a 60-d experiment to determine the effects of sorghum variety on growth and carcass characteristics. There were 40 chicks/pen and seven pens/treatment with feed and water consumed on an ad-libitum basis. The control diet was corn-based with fishmeal and peanut cake used as the primary protein supplements. The diet was formulated to 1.3, 1.1, and 1.0% Lys for d 0 to 21, 21 to 42, and 42 to 60, respectively. Sorghum was used to replace the corn on a wt/wt basis so that treatments were: 1) corn (imported from Nigeria)-based control; 2) a locally adapted landrace variety of sorghum (Mota Galmi) with red seed, purple plant, and 0.3 mg catechin equivalents/100 mg of grain DM; and 3) an agronomically improved variety of sorghum (IRAT 204) with white seed, tan plant, and no detectable tannins. Average daily gain (ADG) and average daily feed intake (ADFI) were greater ($P < 0.001$) for chicks fed corn vs the sorghums. However, most of this difference was caused by the low ADG and ADFI for chicks fed the improved sorghum variety vs the locally adapted sorghum variety ($P < 0.001$). Gain to feed ratio (G:F) was not different ($P > 0.28$) among chicks fed the treatments. Carcass weight, carcass yield, and carcass fat were not different for corn vs the sorghums ($P > 0.35$) but chicks fed the locally adapted sorghum variety had greater carcass weights and yield than those fed the improved sorghum variety ($P < 0.02$). For the corn, locally adapted landrace sorghum, and agronomically improved sorghum, ADG was 37, 35, and 31 g/d, ADFI was 77, 72, and 65 g/d, G:F was 0.48, 0.49, and 0.48 g/g, carcass weight was 2,054, 2,061, and 2,018 g, and carcass yield was 76.0, 76.6, and 74.7%, respectively. In conclusion, the locally adapted landrace sorghum was superior in nutritional value to the agronomically improved sorghum and comparable in nutritional value to imported corn. Sorghum Corn Poultry.

Effects of sorghum variety on growth and subsequent egg production in layers reared in West Africa.

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A total of 450 1-d-old layer chicks (Harco line with an initial body weight of 29 g) were used in an 18-month experiment to determine the effects of sorghum variety on growth and egg production. There were 50 chicks/pen and three pens/treatment with feed and water consumed on an ad-libitum basis. The control diet was corn based with fishmeal and peanut cake used as the primary protein supplements. The control was formulated to exceed recommendations for all nutrient concentrations as suggested in the 1994 NRC for poultry. Sorghum was used to replace the corn on a wt/wt basis so that treatments were: 1) corn (imported from Nigeria)-based control; 2) a locally adapted landrace variety of sorghum (Mota Galmi) with red seed, purple plant, and 0.3 mg catechin equivalents/100 mg of grain DM; and 3) an agronomically improved variety of sorghum (IRAT 204) with white seed, tan plant, and no detectable tannins. For d 0 to 126, there were no differences ($P > 0.12$) in average daily gain (ADG) and gain to feed ratio (G:F) among

birds fed the corn and sorghum treatments. However, the numerical advantage in ADG for birds fed the agronomically improved sorghum resulted in a 79 g advantage ($P < 0.001$) in body weight at the beginning of the laying period compared to birds fed the locally adapted sorghum. For the laying period, birds fed the sorghum grains took fewer days to come into production ($P < 0.007$), ate more feed ($P < 0.02$), and produced more eggs ($P < 0.001$) than birds fed the corn-based diet. There were no differences in average egg weight and egg:feed ratio among birds fed corn and the sorghums. Means for corn, locally adapted sorghum, and improved sorghum were 1,855, 1,840, and 1,919 g body weight at 126 days, 141, 135, and 133 d to reach 20% production, and 47, 56, and 55% production for the entire laying period. In conclusion, sorghum grain was equal (if not superior) to corn as a feedstuff in diets for layers reared in West Africa.

Evaluating genetic resources for drought tolerance in grain sorghum (Poster)

R.N. Mutava, P.V.V. Prasad, K.D. Kofoid, M.R. Tuinstra and J. Yu

Grain sorghum (*Sorghum bicolor* L. Moench), which has its origins in Africa, is the fourth most important cereal crop after wheat, rice, and maize, and is now grown throughout the semiarid tropical and semiarid temperate regions of the world. From the time the domestication of sorghum commenced, around 4,000 – 3,000 BC, numerous varieties have been developed through farmer selection. These improved sorghum types spread through the movement of people and trade routes into other regions of Africa, India (approx. 1500 – 1000 BC) and the Middle East (approx. 900 – 700 BC). The genus *Sorghum* is very diverse and all cultivated sorghums belong to *Sorghum bicolor* ssp. *bicolor* which is divided, based on morphology, into five races (bicolor, caudatum, guinea, durra, and kafir), along with ten intermediate races resulting from inter-racial crosses. Although the US National Plant Germplasm System (NPGS) maintains a large collection of accessions, the genetic base used in sorghum breeding programs is still small. An association panel of 300 sorghum genotypes, which is believed to be representative of sorghum globally, has been developed for genetic studies in sorghum. The goal of this study was to characterize the association panel for physiological traits associated with pre- and post-flowering drought tolerance. The objectives were to (i) quantify the performance of the association panel under field conditions in Kansas, (ii) characterize the sorghum association panel for phenological, physiological and yield traits that might be associated with pre-flowering and post-flowering drought tolerance, and (iii) identify drought tolerant lines with higher yield potential that may be used in the sorghum breeding program. Results from the study indicated that there is a wide genotypic, phenotypic and yield variability within the diversity panel. The race caudatum has a higher potential for use in the sorghum breeding programs due to its higher yields and genotypic stability. Genotypes with potential tolerance to drought were identified in each race, and mechanisms associated with drought tolerance are being investigated. Increased drought tolerance will have potential role to improve productivity of sorghum in semi-arid regions of Africa and elsewhere.

Soil chemical indicators of environmental change in western Senegal

R. Ndiaye

Mboro Niaye is situated along the Atlantic coast in Western Senegal. The climate has an important annual rainfall deficit, which limits local agricultural production. The future of agriculture in the region is dependent on the ground water aquifer which is supplied by precipitation. Interpretation of the physical and chemical character of soils from Niaye indicates the vulnerability of the local environment, specifically the soils inside topographic depressions. Results indicate that agricultural soils have decreased in quality from 1962 to 2004 with losses in organic matter and nutrients. Among the different soil types that have been identified in this area, hydromorphic soils, which situated in the bottom of the depressions, are affected by acidification. All other soil types show evidence of salinization, sodication, and a decrease in fines particles. Soil salinization and sand deposition in the interdunal areas compromise local agricultural productivity and long-term sustainability. Soils and ground water overuse for economic activity contribute to the degradation of the environment and natural resources.

Vegetative and seed reproduction in African savanna grasses in changing environments

J. Ott, D. Hartnett, and M. Setshogo

Many livelihoods and conservation efforts in African savannas rely upon the sustainability of perennial grasses, a primary component of the savanna ecosystem. Aboveground regeneration of grass plants is dependent on the previous dormant season's belowground bud bank and flowering success. To better understand these means of plant and population persistence, bud banks and flowering rates were examined in thirteen perennial grass species in semi-arid savanna in Botswana. In addition, we examined the relationship between grass bud bank densities and flowering and other traits including palatability, longevity, and successional status. Among species, bud banks ranged in average size from 0.36 to 3.36 buds per parent tiller and flowering proportions ranged from 0.10 to 0.94. A direct tradeoff between bud bank size and proportion of flowering tillers among these species was not observed. Short-lived early successional species had the highest proportion of flowering tillers and the smallest bud banks, while the long-lived, climax species had a low proportion of flowering tillers and large bud banks. Those species most palatable to grazers also had the largest bud banks compared to unpalatable species, indicating that regeneration from belowground buds may be an important mechanism of grazing tolerance in savanna grasses. The maintenance of a large reserve of belowground buds may also confer increased drought resistance in savanna grasses. Understanding how bud banks relate to flowering and plant persistence at the population level will build a foundation for understanding how grasses contribute to and sustain savanna ecosystems. A clearer understanding of the reproductive strategies of these key resources may also indicate how they may respond to environmental change.

Mycorrhizal Symbiosis in Southern African Savanna Grasses

G. Wilson and D. Hartnett

Studies conducted in North American grasslands have shown that the mutualistic symbiosis between grasses and mycorrhizal fungi is a key factor influencing plant growth, competition, population and community dynamics, and responses to fire and herbivory. In savannas of Sub-Saharan Africa, understanding the potential role of mycorrhizal symbiosis in grasses is important because the sustainability of perennial grass populations is crucial to ecosystem function and to the support of human livelihoods. The factors controlling the abundance and distribution of mycorrhizal fungi and the ecological consequences of this symbiosis remain poorly understood. We sampled 16 grass species in semi-arid savanna at Khama Rhino Sanctuary, Botswana and 18 species in Kruger National Park, South Africa. All African grass species were highly colonized by arbuscular mycorrhizal fungi, with colonization levels 2 to 3 times higher than those typically found in grass species of North American grasslands of similar soil fertility and precipitation. Among sites, the abundance of mycorrhizas decreased with increasing mean annual precipitation, indicating that the symbiosis is more important in semi-arid to arid savanna ecosystems. The greater abundance and development of mycorrhizal symbiosis in African grasses may reflect a longer co-evolutionary association of mycorrhizal fungi and their host plants in African ecosystems, differences in levels of herbivory, or other soil differences resulting in lower availability of phosphorus and other mineral nutrients to grasses in African savannas compared to North American grasslands.

ANTISICKLING ACTIVITY OF SOME MEDICINAL PLANTS FROM CONGOLESE BIODIVERSITY

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Each year, over 300,000 children are born affected by drepanocytosis and half of them die before the age of 5 years¹. This sickle cell anaemia is a genetic disease due to a mutation in position 6 within the β chain of hemoglobine whereby glutamic acid is replaced by valine². Antisickling activity of six Congolese plants (*Ocimum basilicum*, *Hymenocardia acida*, *Alchornea cordifolia*, *Vigna unguiculata*, *Annona senegalensis* and *Jatropha curcas*) were evaluated using Emmel test³⁻⁷. The ratio of normalisation (RN) of drepanocytes and the minimal concentration of normalization (MCN) have been determined. Anthocyanin extracts from each plants exhibited significant activities. *O. basilicum* total ethanol extract displayed MCN = 2.5 mg/ml and RN = 87 % while its anthocyanin extract displayed MCN = 0.2 mg/ml and RN = 96 %. *H. acida* total water displayed MCN =156.25 mg/ml and RN = 80 %. Anthocyanin extracts from *Alchornea cordifolia*, *Vigna unguiculata*, *Annona senegalensis* and *Jatropha curcas* displayed MCN = 0,2 μ g/ml; 39,06 μ g/ml; 30 mg/ml and 300 μ g/ml respectively. These MCN correspond to RN = 96 %; 73 %; 72 % and 67 % respectively. *Annona senegalensis* acetylated anthocyanins have also showed a high rate of normalization (RN = 81%). Thus, this fact supports and justifies the claims of Congolese traditional healers. It also suggests a possible correlation between the chemical

composition of these plants and their uses in traditional medicine. Kinetic of thermic degradation (temperature range 50-125°C, during 24 hours) of anthocyanin extracts and one isolated compound from each plant was performed in order to establish conservation conditions. The thermic stability studies of two anthocyanins chromatographically homogeneous compounds showed that they are stable below 100°C, but are temperature and time dependent above 100°C ($k = 0.95 \text{ h}^{-1}$ for *H. acida* compound and $k = 1.09 \text{ h}^{-1}$ for *O. basilicum* compound at 100°C). Photochemical stability of the anthocyanin extracts and structural elucidation are still on study.

Institute for Grassland Studies

A. Joern and D.C. Hartnett

The new Institute for Grassland Studies is a Targeted Excellence Program of Kansas State University. With an emphasis on conservation, management, and sustainable ecological responses to global environmental change, the grasslands of Kansas and IGS provide unique insight into the functioning and biodiversity of grasslands, the dominant ecosystems supporting human sustenance and agricultural economies worldwide. The Konza Prairie Biological Station at KSU provides context for IGS research along with projects representing 14 KSU departments, over 60 visiting scientists and students from the U.S. and abroad, and multiple national and international environmental research organizations. The primary goals of this program seek to promote professional interactions with prominent international grassland scientists from around the world in ways that foster new research and educational opportunities and the synthesis and application of grassland science for improved conservation and global sustainability.

Sew Kenya

D. Dias

In the summer of 2008, I spent 3 days in Kenya teaching the amazing women basic sewing skills. All of these women have one or more children with a mental and/or physical disability. So for them to learn to sewing skills is priceless, since they have limited access to education, and jobs are rare. They have been producing canvas bags, which provide two purposes: 1) to provide an income for them and for their families, and 2) to promote environmental sustainability in Kenya and abroad.