Research Priority Setting for the Feed the Future Innovation Lab for Collaborative Research in Sorghum and Millet in Ethiopia, Niger and Senegal:

A Synthesis of Country Reports

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Background and Introduction to the SMIL Program

The Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet will develop a portfolio of research activities that will respond to the needs of the sorghum and Pearl millet research communities in Ethiopia, Niger and Senegal. To achieve this, input from a broad range of stakeholders was elicited in each of the focus countries on the strategic direction of research investment. Meetings were held in Ethiopia, Niger and Senegal to define the key constraints facing sorghum and Pearl millet value chains. This report describes findings from each of these meetings and the process used to elicit this information. Country-specific reports are available for greater detail but the reports for Senegal and Niger are in French only. These reports are available at https://smil.k-state.edu/country-prioritization.

A similar approach was followed in each country. Participants were briefed on the goals and objectives of USAID's Feed the Future (FtF) initiative with explicit attention given to the overall goal of "Sustainably reduce global poverty and hunger" by meeting the objectives of "Inclusive agriculture sector growth" and "improved nutritional status" especially of women and children. They were then presented with the three areas of inquiry defined for the program: 1) Genetic enhancement, 2) Production systems management, and 3) Market development and added-value products research. Cross-cutting issues of gender, nutrition and the environment are also areas of focus.

Research conducted in each of the areas must be interdisciplinary where possible. The combination of activities under these areas of research should be integrated into a program of "demand driven research to enhance food security." In addition to these research areas, Human and Institutional Capacity Development (HICD) are seen as key elements of the future of the Sorghum and Millet Innovation Lab (SMIL).

Several meetings over the past year have focused on defining the key constraints limiting the development of the sorghum and Pearl millet value chains in numerous countries and regions of Sub-Saharan Africa. From September 2-6, 2012 ASARECA and INTSORMIL conducted a workshop to discuss national and regional sorghum research and development areas and important research topics were identified (ASARECA-INTSORMIL 2012). The Bill and Melinda Gates Foundation conducted a "Sorghum and Millets Value Chain Convening" from July 26-27, 2012 (Bill and Melinda Gates Foundation 2012). Other published studies have also attempted to regroup constraints including Waddington et al. (2010). These constraints are reviewed in order to contribute to defining research opportunities for each country.

Priority Research Issues and Areas in Ethiopia

Tables 1 present a summary of the constraints identified in several previous studies plus those that were discussed during the research priority setting meetings in Ethiopia in early 2013.

Table 1. Constraints facing the production and marketing of sorghum in Ethiopia

Source	ASARECA-INTSORMIL Regional Sorghum Research and Development Workshop, 2012	BMGF Convening, 2012	Waddinton et al., 2010: Highland Temperate	Waddinton et al., 2010: Maize Mixed	Additional issues defined on February 21, 2013 and in "Ethiopian Sorghum Research and Development Strategy"
Abiotic	Drought tolerance, early maturing cultivars	Drought	Nitrogen deficiency, drought, soil physical degradation, fertility depletion	Soil physical degradation, drought (establishment and grain filling), nitrogen deficiency	Frost/cold tolerance in highlands, regional differences of abiotic constraints
Biotic	*Striga*, pests	*Striga*, insect pests, birds	Leaf, stem, panicle pests, weed competition,*Striga*	Weed competition, bird damage	Regional differences of biotic constraints, bird damage, diseases (*Quelea quelea)*
Management	Mechanization, Integrated pest, soil and water management,		Crop establishment		Best bet land-use practices, Inadequate package of improved crop management practices
Post harvest	Grain quality, handling, public private partnerships for products	Lack of platform for value chain; malting, feed industry	Inadequate utilization knowledge	Inadequate utilization (post harvest) knowledge	Varieties with desirable post-harvest and organleptic traits, other end-use traits, improved storage methods and structures
Socio-economic	New products, regional integration, value chain integration, adoption constraints, seed availability, farmer information	Lack of effective seed system, informal seed	Inadequate farmer production knowledge	Insufficient access to agricultural information	Economic evaluation of components, technology transfer, psychology of adoption, transportation and transaction costs limiting trade, discriminatory government policy, no agroprocessing industries, commercial farming

In Ethiopia, researchers argued that these constraints should be broken out according by agroecology and regrouped to facilitate discussion. Three research themes were recognized in Ethiopia: 1) Low sorghum productivity in Ethiopia's agroecologies, 2) Utilization and marketing of sorghum, and 3) Technology transfer and seed systems. It was suggested that Theme 1 could be broken down into sub-areas based upon agroecologies in order to better reflect the differential prevalence of stresses and opportunities specific to each ecology. This reorganization is slightly different than the Areas of Inquiry defined in the RFA and the previous section, but consistent with the research strategy overall. It is only a reorganization of the areas of Inquiry.

Theme 1 concentrates on integrated research on genetic enhancement (Area of Inquiry 1) and production systems management (Area of Inquiry 2) with strong elements of gender and environment (cross-cutting issues). Theme 2 concentrates on integrated research on genetic enhancement in areas of end-use traits (Area of Inquiry 1) and market development and added value products (Area of Inquiry 3) with strong elements of gender and nutrition (cross-cutting issues). Theme 3 integrates all three areas with strong elements of gender, environment and nutrition. Table 2 suggests a qualitative composition of disciplinary fields that are likely to collaborate and the importance of each of these fields in the research themes. The low sorghum productivity theme could be broken down into specific abiotic and biotic constraints and management strategies that limit sorghum productivity.

Table 2. Thematic research areas, interdisciplinary research opportunities and suggested importance of scientific field in Ethiopia

Theme	Disciplines				
	Breeding	Plant Protection	Agronomy	Food Science	Social Sciences
1. Low sorghum productivity					
1.a Highland	5	2	5	5	3
1.b Mid-Altitude	5	2	5	4	3
1.c Dry lowlands	5	5	5	4	3
1.d Moist lowlands	5	5	5	4	3
2. Utilization and Marketing	5	3	1	5	5
3. Technology Transfer and Seed Systems	4	3	3	3	5
Notes: Scale: 5=Essential, 4=Very important, 3=Strongly important, 2=Moderately important, 1=limited role, 0=nonessential					
Breeding includes additional fields such as physiology, genetics and biotechnology etc.					
Plant protection includes fields such as plant pathology, entomology, weed science and nematology etc.					
Agronomy includes fields such as agronomy, soil science, cropping systems, climate, hydrology, natural resource management etc.					
Food science includes food scientists, nutritionists, grain scientists, post-harvest specialists etc.					
Social sciences include agricultural economists, sociologists, anthropologists, agribusiness etc.					

Priority Research Issues and Areas in Niger and Senegal

In Niger and Senegal, both Pearl millet and sorghum research areas were discussed. Overall many of the same production constraints and areas of research were common to both crops with the exception of some biotic constraints, post-harvest, market and product issues. Table 3 presents a summary of the constraints facing the Pearl millet and sorghum value chains in the two countries.

Table 3. Constraints facing the production and marketing of Pearl millet and sorghum in Niger and Senegal

	Sahel	Niger		Senegal	
	Waddington et al. (2010)	Country consultation		Country consultation	
Source	Sorghum Constraints	Sorghum Constraints	Pearl millet Constraints	Sorghum Constraints	Pearl millet Constraints
Abiotic	Drought, dry spells during development and grain filling, nitrogen deficiency	Low soil fertility, P deficiency, erratic rainfall, high temperature, flooding, wind, GxE interactions	Low soil fertility, P deficiency, erratic rainfall (drought and flood), G x E interactions	Phosphorous deficiency, drought tolerance, heat tolerance	Phosphorous deficiency, drought tolerance, heat tolerance
Biotic	*Striga*	Grain mold, *Striga,* low productivity cultivars, midge, mildew, long smut, shoot fly, stem borer, rodents	*Striga* stem borer, head miner (worm), Downy mildew, mold, rodents	Sorghum midge, head smut	Downy mildew, head miners,
Management	Inadequate fertilizer use and management, variable planting times, unsuitable plant population density, bird damage	Moisture conserving cropping systems, soil fertility management, technology packages, weak extension education,	Moisture conserving cropping systems, soil fertility management packages, mechanization	Water harvesting, Irrigation, seed density, crop rotations, intercropping, soil x G interactions, fertilizer recommendations	Water harvesting, Irrigation, seed density, crop rotations, intercropping, soil x G interactions, fertilizer recommendations
Post harvest	Inadequate utilization knowledge	Desirable (white) seed color, seed and grain storage, grain quality, tuwo quality, storage infrastructure, forage end-use, feed grains, "dense feeds", price risk, storage pests	High level of impurities, low uniformity, low processing capacity, low shelf life for sorghum and millet flour, Zn and Fe content, storage pests, price risk, storage pests including rodents	Local storage options, post harvest pest control, milling and processing equipment, packaging and product marketing	Local storage options, post harvest pest control, milling and processing equipment, packaging and product marketing
Socio-economic	Difficult formal market access, fertilizer expensive	Markets for sorghum (brewery, poultry feed, forage), seed and other input availability, low adoption rates of technology, extension, weak understanding of value chain, farmer empowerment, risk management, business incubation platform, consumer preferences	Availability of improved seed and other production inputs, value chain organization, rural grain processing technology, risk management, business incubation platform, consumer preferences	Seed and Input supply, risk management, government subsidies, insurance, marketing consumer preferences, entrepreneurial skills, farmer cooperatives, local grain processing, outreach and extension	Seed and Input supply, risk management, government subsidies, insurance, marketing consumer preferences, entrepreneurial skills, farmer cooperatives, local grain processing, outreach and extension

Identifying Weaknesses in the National Research Systems

Each nation conducted an analysis of the strengths and weaknesses of their research capacities in sorghum and Pearl millet. Participants indicated that the system has significant human resource limitations that could be addressed through the SMIL program. These human resource needs and their importance are described in Table 4 for Ethiopia, Table 5 for Niger and Table 6 for Senegal.

These tables help to illustrate that there are numerous impediments to achieving the desired results of each of the three thematic areas and these impediments are found both in the human capacity to undertake research and the supporting institutional infrastructure. For example, Theme 1 in Ethiopia requires human resources in the area of breeding, plant protection and agronomy yet human resource needs are the highest in the breeding area. The weakness assessment also indicates that there is a lack of important infrastructure to conduct research in plant breeding and pathology due to a lack of greenhouses, irrigation and disposable supplies. Limitations in human resources for plant protection and agronomic research also effect research productivity. The lack of food scientists and limited resources available for breeding for specific end-use traits is an identified constraint in Ethiopia. Lack of social scientists, important in each of the themes, may limit progress in all themes. Economists are required to evaluate the value of strategies to increase economic productivity of new crop and resource management technologies, sociologists or economist to evaluate the gender impacts of technologies and marketing strategies. Other weaknesses were noted (described in Appendix 1 for Ethiopia) of which only a limited number could possibly be addressed through the SMIL research program.

Table 4. Weaknesses in human capacity and physical infrastructure of the sorghum research program In Ethiopia

Human Capacity Weaknesses	Physical Infranstructure Weaknesses
Breeding (6)	Crop improvement and molecular tools/crossing facilities (5)
Physiology (3)	Greenhouse (4)
Genetics (2)	Supplies, chemicals (lab and field) (3)
Pathology (3)	Field vehicles (2)
Plant protection	Cold room (2)
Entomology	Irrigation (2)
Agronomy (2)	Journals, electronic documents (2)
Natural resource management	Laboratory equipment
Food science (3)	Computing facilities
Social sciences (3)	
Business development	
Extension (2)	
Biometrics	
Workshop facilitation	
Research & admin support staff (2)	

Note: Number in parentheses indicates the number of times participants cited an area

Table 5 presents a summary of the human capacity and infrastructure constraints identified during the priority setting workshops. Several of the constraints on human capacity do not indicate that the skills are absent from the national program. This will require additional development, for example, higher degree training at the Ph.D. level from a M.S. level or an equivalent degree. It was also emphasized that several of the researchers in the Nigerien system are nearing retirement age and this will create a constraint in the future if replacements are not trained.

Table 5. Weaknesses in human capacity and physical infrastructure of the sorghum and Pearl millet research program in Niger

Human Capacity Weaknesses	Physical Infrastructure Weaknesses
Applied Economics	Biotechnology laboratory and supplies
Biometrics	Computing hardware
Climatology and climate science	Irrigation systems for breeding and seed production
Communication and Outreach	Soil science equipment
Food science	Pathology screening equipment and supplies
GIS	
IPM	
Mechanization	
Pathology	
Physiology	
Seed Technology	
Sociology	
Soil Science	

Table 6 presents the results of the needs assessment in Senegal. The results from this assessment are largely consistent with those conducted in Ethiopia and Niger. Again, it was emphasized that there is an overall aging of the scientific staff and several are nearing the official retirement age. It was also emphasized that there are several needs for training technical support staff that do not require long-term degree training but rather short courses.

Table 6. Weaknesses in human capacity and physical infrastructure of the sorghum and Pearl millet research program in Senegal

Human Capacity Weaknesses	Physical Infrastructure Weaknesses
Aging of most researchers	Food technology
Food safety	Gene bank for sorghum and millet
Food science	Information systems
Food technology and processing	Laboratories and workshops for mechanization
Marketing	Sensory analysis laboratory
Mechanization	Storage
Molecular biology	
Nutrition	
Pathology	
Post harvest and Storage	
Sensory analysis	
Social Science	
Soil Science	
Technical support staff	
Technology transfer	
Weed science	

Strengths of the NARS and Opportunities for Impact

All national programs expressed limitations but they also identified strengths that collaborative research can build upon. All participants agreed that there are substantial strengths in the Ethiopian NARS for sorghum. These strengths can be described as a strong national program with excellent research coordination, a long-term history of successful research management, a well-established network of research organization and good government support for operations. Researchers are dedicated. Participants note that there is strong demand for research products because of the national and regional demand for sorghum. Diverse sorghum genetic resources provide a foundation to develop new varieties and the diverse agroecologies are a potential laboratory to generate scientific advances that may spillover to other nations with similar conditions.

In Niger, several strengths can be combined with SMIL projects including access to nearly 90% of the genetic diversity of Pearl millet, a long history of experience in sorghum and millet research and a large collection of improved sorghum varieties including an advanced hybridization program. Over 1,139 Pearl millet cultivars have been morphologically characterized by Institut National de la Recherche Agronomique du Niger (INRAN) There exist business incubation centers for sorghum and Pearl millet that includes processors working in collaboration with research on new products and small-scale transformation technologies that are adapted for non-urban environments. The private sector is also interested in collaborating on seed multiplication.

In Senegal, the private sector is actively engaged with research to improve grain handling, processing and the development of new food products, especially in collaboration with ITA. Capacity to conduct

research by the national program and L'Institut de Technologie Alimentaire (ITA) is high especially given the long-term collaboration with INTSORMIL. There are well equipped laboratory facilities at ITA and they coexist with a training center capable of hosting short-term workshops. The Institut Senegalais de Recherches Agricoles (ISRA) hosts the regional center of excellence for dryland agricultural research (www.ceraas.org). Collaboration with researchers at this center could also contribute to broader regional impact by nature of their mandate in West Africa.

Synthesis

This report has summarized findings from planning and prioritization meetings held in Ethiopia, Niger and Senegal. Reports from each of these three meetings are available for greater precision on the issues, constraints and opportunities facing the sorghum and Pearl millet research communities in each nation. These reports serve as a basis for defining the areas of investment for the Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet. These reports synthesize country planning meetings and other sources of information, e.g. meetings with the private sector, international organizations, USAID country and regional missions, to structure the direction of research investment. Attempts were made to be as inclusive as possible in the collection of this information.

In each report, a list of participants is attached. These lists can serve as a clearing house for potential collaborators who are interested in collaborating on research projects. These lists should not be considered the sole source of potential collaborators.