Site-specific work plans

The IFAD-EU NUS Project in Mali

Promoting fonio (*Digitaria sp.*), Bambara groundnut (*Vigna subterranea*) and nutritious underutilized vegetables in Sikasso and Ségou regions of Mali

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Introduction

The Project 'Linking agrobiodiversity value chains, climate adaptation and nutrition: Empowering the poor to manage risk' will be implemented in Mali by the Institut d'Economie Rurale (IER), which is the main research institute in the country in charge of agricultural research and development. IER's mandate is to undertake and facilitate research activities that contribute to better performance of crop, animal, fish and tree resources to ensure food security and income generation for the people of Mali. The institute puts farmers at the centre and uses participatory approaches in all their activities related to plant and animal breeding, soil and water analysis, pathology and entomology, sustainable cropping systems, integrated agricultural development, capacity building, gender and development, natural resource management, agricultural enterprises, food technology, and animal nutrition and genetic resources management, conservation, and sustainable use

Through its Genetic Resources Unit, IER has worked in close collaboration with Bioversity International since 1999. In the course of the joint implementation of several projects, the partnership has strengthened the capacities of actors involved in the conservation and sustainable use of plant genetic resources in Mali and developed approaches for seed diversity fairs, diversity fields, diversity kits, community seed/gene banks and costing the benefits of conservation of genetic diversity for major crops. The IFAD-EU NUS Project will build and expand on these efforts, promoting use and cultivation of underutilized crops with high potential to strengthen food and nutrition security and livelihood resilience of rural communities facing climate change.

Context

Mali is a landlocked country in the heart of West Africa. The majority of its land surface is characterized by a hyper-arid to arid climate. 51% of the land area falls in the desert eco-zone (annual rainfall 0 to <250mm) and 26% in the Sahel zone (250-550mm) (Coulibaly 2006). The climate is more benign, with higher levels of rainfall, toward the south: the Sudanese zone is characterized by a semi-arid to sub-humid climate (550-1100mm) and the pre-Guinean zone is characterized by a sub-humid climate (>1100mm). These more humid southern zones are only a small amount of Mali's land area (17% and 6%, respectively) but the population is concentrated in these regions.

Peoples' livelihoods are closely related to the land in Mali. The national economy is largely (35%) based on the agricultural sector and the majority of the population is rural (78%) with livelihoods based on farming or pastoralism (IFAD 2011). Different ethnic groups have distinct livelihood strategies: the Bambara, Senoufo, Mianka, Foulany, Bobo, Malinke, Sarakole, Dogon and Songhay are mostly settled farmers (agriculturists or agro-pastoralists), the Fula, Touareg and Maure in the northern regions are mostly herders, and the Bozo are fishers primarily settled along the Niger River (Minority Rights Group International 2015). Farmers' landholdings are typically small, with

85% having less than 10 hectares and the average plot size being 4.7 hectares (FAO & SICIAV 2010). 87% of national agricultural production is for home consumption (CFSVA 2005) and almost all the farmland is rainfed (IFAD 2011), making the production highly vulnerable to climate hazards.

Food insecurity and malnutrition are major issues in Mali, which are more pronounced in rural areas. The country experiences severe food shortages generally one year in three (CFSVA 2005) and faces a lean period every year from July–September before the crops are harvested. Stunting, wasting, and underweight are prevalent, estimated at 38%, 15% and 27% respectively in children under 5 years of age (FAO & SICIAV 2010). Micronutrient deficiencies are also highly prevalent. Anaemia, often linked to iron deficiency, is a critical issue: 81% of children aged 6-59 months were found to display anaemia and 10% severe anaemia in 2007 (FAO & SICIAV 2010). A strong urbanization has occurred in recent years and obesity and overweight cases are increasingly recorded among the urban middle class that is consuming foods high in carbohydrates and fats (FAO & SICIAV 2010). In Bamako, the prevalence of overweight and obesity is 31%, which is a trend linked to risk factors of diabetes, cardiovascular disease and cancer (Fanou-Fogny 2012).

The most food insecure regions of Mali are the north (Kidal, Gao, and Tombouctou - especially the lake area), the south of Kayes and Koulikoro, the north of Ségou, and specific areas in Mopti (the Dogon plateau, Niger delta, and Douentza Cercle) (CFSVA 2005). Sikasso and Ségou have lower rates of food insecurity than the rest of the country but still 25% of households are food insecure or highly vulnerable (CFSVA 2005). Despite having relatively better access to food and being the main cereal basket of Mali, Sikasso actually has the highest rates of chronic malnutrition in the country (CFSVA 2005). Diets are more diverse in Sikasso and Ségou, as households more commonly consume fruits and vegetables, but low consumption of milk and meat in these regions is linked to higher rates of vitamin A and iron deficiency than other regions (FAO & SICIAV 2010). Only 33.6% of the Malian population is literate (IFAD 2011) and a major barrier in proper nutrition is mother's education, which is related to the adequacy of child feeding practices. Stunting was found to be double for children of uneducated women compared to those with secondary education or greater (FAO & SICIAV 2010). As half of rural households in Mali live below the poverty line (IFAD 2011), the lack of purchasing power is also a barrier to food security for many households, particularly in north where there is greater dependence on purchased foods (FAO & SICIAV 2010, CFSVA 2005).

Climate is a fundamental constraint for food security in Mali (CFSVA 2005). The climate features a long dry season (October/November to May/June) and a short rainy season (June to September) (FAO & SICIAV 2010). Frequent drought and drying of water bodies underlie a state of chronic food insecurity in the northern regions and are the most important hazards for food security in the south because of high dependence on subsistence agriculture (CFSVA 2005). With already harsh conditions for agriculture, climate change is a major threat to food security in Mali. Variation in precipitation patterns have occurred in recent years, including delayed onset of the rainy season, irregularity of rainfall, early cessation of rains, and less precipitation overall. Rainfall declined 20% from 1951 to 2000 and a general shift of climate zones southward has occurred, raising alarms about desertification. With heat and drought already major constraints to food production in Mali, the increasingly arid conditions could have severe consequences for food security unless action is taken to adapt.

The major food crops in Mali are pearl millet (*Pennisetum glaucum*), rice (*Oryza sativa* and also to a smaller degree native *O. glaberrima*), sorghum (*Sorghum bicolor*), and maize (*Zea mays*). The important cash crops are cotton, tobacco and peanut, the latter which is also grown as a food crop [2]. Other important minor food crops are cowpea (*Vigna unguiculata*), Bambara groundnut (*Vigna subterranea*), and fonio (*Digitaria exilis*, *Digitaria sp*.). Popular vegetable crops are lettuce (*Lactuca sativa*), onion (*Allium cepa*), bell and chili peppers (*Capsicum annum*, *Capsicum frutescens*), tomato (*Lycopersicon esculentum*), and cabbage (*Brassica oleracea*), which have their origins outside of the region. Many other native and naturalized vegetables also continue to be cultivated on a smaller scale (Box 1). Cultivated trees in Mali include mango (*Mangifera indica)*, papaya (*Carica papaya)*, guava (*Psidium guajava)*, sugar apples (*Annona squamosa)*, and various *Citrus* species (oranges, lemons, grapefruit, etc.). Cereals make up 72% of arable land in Mali, while cash crops make up 19% (FAO & SICIAV 2010).

Production of rice and maize has expanded in Mali since the 1990s displacing traditional crops like pearl millet and sorghum (FAO & SICIAV 2010), Diallo 2011). Rice cultivation expanded as a result of government investment in irrigation, notably in Ségou region (Ministry of Agriculture 2009). Its production has not kept pace with rising consumer demand, however, as rice has become the predominant staple in urban areas and is increasingly consumed in rural areas (Fogny-Fanou 2012, Ministry of Agriculture 2009). There is consequently high dependence on imported rice in Mali, which comes mostly from Asia with volatile prices (Ministry of Agriculture 2009). Production and consumption of maize has also increased in Mali as a result of government research and promotion, particularly in Sikasso region, where fast-maturing varieties of maize (as short as 65-75 days) are a critical lean season food (Diallo 2011, Laris 1995). Maize is promoted because it has the highest yield potential of the coarse grains but a major constraint is that it depends on good rainfall, which is increasingly unstable in Mali (Diallo 2011). Maize is also expensive to due to the cost of seed and dependence on fertilizer, which is a barrier for farmers to cultivate this crop (Diallo 2011).

An important aspect of traditional agricultural practice in Mali is the correspondence between the varieties cultivated and the soil and climate conditions. Many varieties are disappearing, however, due to agricultural modernization (shift to extensive agriculture) and climate change.

Box 1. Native and naturalized vegetables cultivated and collected in Mali and Dry West Africa. Source: Shackleton, Pasquini and Drescher (2009).

Field crops and gathered forbs
Abelmoschus esculentus (common okra) and *Abelmoschus caillei* (West African okra); *Amaranthus sp.* (wild spinach), including native *Amaranthus graecizans* and introduced species *Amaranthus cruentus, Amaranthus caudatus,* and *Amaranthus viridis; Cleome gynandra* (spider plant; leafy vegetable); *Corchorus olitorius* and wild relative *Corchorus tridens* (jute mallow; leaves); *Cucurbita maxima* (pumpkin; fruits), *Cucurbita pepo* (pumpkin; leaves and fruits), and *Cucurbita moschata* (pumpkin; fruits); *Hibiscus subdariffa* (roselle; young calyxes); *Ipomoea batatas* (sweet potato; leaves; naturalized from Americas); *Luffa cylindrica* (spongegourd; fruits) which grows wild in West Africa but its use is limited as people prefer to use *Luffa acutangula* that was naturalized from Asian origin; *Solanum aethiopicum* (eggplant; fruit), *Solenostemon rotundifolius* (fra fra potato; tubers); *Trichosanthes cucumerina* (snake gourd; naturalized from Asian origin); *Vigna unguiculata* (cowpea; leaves)

Trees and shrubs
Adansonia digitata (baobab; fruit and leaves), *Balanites aegyptica* (desert date; fruit, seed, leaves), *Bombax costatum* (leaves and flowers, fruit), *Daniellia oliveri, Ficus* sp., *Grewia mollis, Khaya senegalensis, Moringa oleifera* (drumstick; leaves), *Rodognaphalon brevicuspe, Parkia biglobosa* (seeds), *Senna* sp., *Strychnos spinose, Tamarindus indica, Vitex doniana, Vitelaria paradoxa, Zaban senegalensis*

Target Crops

With increasing aridity in Mali due to climate change, increasing the availability and performance of heat and drought tolerant crops will be key in strengthening food security. Traditional West African crops, which are well-adapted to the harsh growing conditions of the region, have received scant research and promotion in comparison to rice and maize but are critical assets to secure livelihoods and nutrition of Malian people in the face of climate change (Tadele & Assefa 2012).

Sorghum, pearl millet and cowpea are native dryland crops that are vital to food and production systems in Mali. Two other traditional crops, fonio and Bambara groundnut, are also important in Malian production systems on a smaller scale. These highly drought tolerant crops, tied to traditional food cultures and risk management strategies, have great potential to improve food security under climate change. However, due to the low of research attention, these crops face many constraints that must overcome to enhance their role in food and nutrition security.

The IFAD-EU NUS Project will focus on Bambara groundnut, fonio and traditional vegetables to build understanding of their constraints for production and use and work to overcome these bottlenecks to support development of more nutrition sensitive and resilient food and livelihood systems in Mali.

Bambara groundnut

Bambara groundnut (known as *voandzou* in Mali) is widely cultivated in semi-arid sub-Saharan Africa. It is the third most important legume in Africa, and Mali, after peanut and cowpea and has an advantage over these crops in terms of its adaptation to poor fertility soil, drought tolerance, and resistance to pests and disease (Table 1; Hillocks, Bennett & Mponda 2012; Brink & Belay 2006).

The seeds of Bambara groundnut, which mature underground, are eaten fresh, dried and boiled, roasted, or ground as flour. Nutrient values differ between varieties and locations but the crop is considered a 'complete food' with an adequate complement of protein, carbohydrates and fat (Azam-Ali et al. 2001). Some studies report that Bambara groundnut has higher protein value than groundnut or cowpea (Azam-Ali et al. 2001, while other sources report slightly lower levels (Table 2). Lipid content is similar to cowpea but inferior to peanut (Azam-Ali et al. 2001). Indeed, Bambara groundnut is believed to have been displaced in West African production systems when peanut was introduced from the Americas for the high export potential of peanut oil (Azam-Ali et al. 2001). Red seeds are higher in iron than cream-colored seeds and could be important in reducing iron deficiency (Bamshiaye, Adegbola and Bamshiaye 2011; Hillocks, Bennett and Mponda 2012). The black seeds have an additional cultural value in Mali, because they are considered a protection against the spirits.

Table 1. Growing preferences for the primary pulses and cereals of Mali. Source: FAO EcoCrop Database, data are not specific to Mali.

Crop	Annual Rainfall (mm)			Temperature (°C)			Soil Fertility		Growth cycle (days)
	Min	Optimal	Max	Min	Optimal	Max	Optimal	Absolute	
Peanut	400	600-1500	4000	10	22-32	45	High	Moderate	90-150
Cowpea	300	500-1500	4100	15	25-35	40	Moderate	Low	30-240
Bambara groundnut	300	750-1400	3000	16	19-30	38	Low	Low	90-180
Sorghum	300	500-1000	3000	8	27-35	40	Moderate	Low	90-300
Pearl millet	200	400-900	1700	12	25-35	40	Moderate	Low	60-120
Fonio	400	900-1600	2800	18	22-27	31	Moderate	Low	9-130

Table 2. Nutrient values of some commonly consumed pulses and cereals of Mali in West Africa per 100g of edible portion. Source: Smith (1995).

Food	Energy (Kcal)	Protein (g)	Thiamine (mg)	Niacin (mg)	Calcium (mg)	Iron (mg)
Peanut	549	23.2	0.79	15.5	49	3.9
Cowpea	342	23.1	0.75	2.5	101	7.6
Bambara groundnut	365	18.8	0.47	1.8	62	12.2
Sorghum	340	9.4	0.25	3.7	45.0	8.8
Pearl millet	341	10.4	0.3	1.7	22.0	20.7
Fonio	332	7.1	0.24	1.9	40.0	8.5
Rice	346	7.0	0.17	5.4	6.0	2.4
Maize	357	9.4	0.33	2.2	16.6	3.6

Bambara groundnut is cultivated primarily by women subsistence farmers and could be an important income opportunity for these producers. Currently, the majority of Bambara groundnut production is destined for home consumption (Bamshiaye, Adegbola and Bamshiaye 2011). However, it is a popular snack food, with a fairly high market price and studies have suggested that demand often exceeds supply (Azam-Ali et al. 2001; Hillocks, Bennett and Mponda 2012).

There are several constraints to increase production and use of Bambara groundnut that have been noted in the literature, including poor germination (INERA 2012), late maturation (Tadele &

Assefa 2012), poor uniformity (INERA 2012), difficulty in mechanical harvesting, that hinders large-scale production, disorganized value chains with poor aggregation of producers, laborious processing due to difficult de-hulling, and long cooking times, that demand more fuel and water than competing legumes like cowpea (Hillocks, Bennett and Mponda 2012). Bambara groundnut is generally under-researched and the most important constraints in Mali are not well documented. The bottlenecks to increase production and use of Bambara groundnut could be overcome given some research attention to develop and introduce appropriate technologies and strengthen the supply chain.

Fonio

Fonio (*Digitaria sp*.) has been cultivated widely in the Sahel and Sudanese zones of West Africa for thousands of years for human consumption. In semi-arid and sub-humid regions of West Africa, the crop occupies 12-23% of cropping area - the third largest area after millet and sorghum (Vall et al 2011). Fonio is a staple or forms a major part of the diet for many rural communities in Mali, contributing 17-21% of cereal requirements (Koreissi 2015, Vall et al. 2011). Ségou and Sikasso are the major fonio growing regions in Mali, which provided 70% of production in 2006-2007 (Koreissi 2015).

Because of the short time to maturation for some varieties (<100 days), fonio holds a central place in the food security strategy of rural families during the lean period before millet and sorghum are harvested (Vall et al. 2011). In the semi-arid zone it is almost exclusively consumed in the lean period (Vall et al. 2011). In the relatively more food-secure semi-humid zone, in addition to using the crop in the lean period, it is also commonly stored and used throughout the year to diversify the diet (Vall et al. 2011). Predictions for climate change in West Africa suggest that the most severe impacts on agriculture will be the result of the reduced length of the growing period, as the rainy season starts later and ends earlier (Tadele & Assefa 2012). Crops with shorter growth cycles, such as fonio, will be increasingly important to secure food production.

Fonio is a fairly nutritious crop, rich in starch and glucidic energy (Koreissi 2015). It stands out for its content of essential amino acids methionine and cysteine, which are deficient in rice, wheat, maize, and sorghum, and generally limiting for the protein quality of West African diets (Tadele & Assefa 2012; Adoukonou-Sagbadja et al. 2006; Annegers 1974). Fonio holds second place after sorghum for iron and zinc in the Table de Composition des aliments du Mali (TACAM; Koreissi 2015). However, traditional processing methods (involving husking, de-hulling, washing and milling) have been shown to significantly reduce the iron content to levels below other cereals commonly consumed in Mali (Fogny-Fanou 2012, Koreissi 2015). The phytate content in fonio also interferes with iron absorption and is not fully eliminated with processing and cooking (Fogny-Fanou 2012, Koreissi 2015). These issues limit the value of fonio in improving iron in Malian diets. However, the crop still shows value as a source of carbohydrate, protein, and zinc. Another appeal is that it is a gluten-free grain and has low glycaemic index, making it suitable for diabetics.

Fonio is considered one of the best tasting African cereals, appreciated by all levels of society (Adoukonou-Sagbadja et al. 2006). For some communities in Mali it is considered the fanciest grain served to guests and at celebrations (Adoukonou-Sagbadja et al. 2006). It has strong traditional significance, holding a central role in women initiation ceremonies, baptism of newborns, and requesting a woman's hand in marriage (Adoukonou-Sagbadja et al. 2006). The Dogon's consider it 'the grain of the world' (Cruz, Beavogui & Drame 2012). The central role of the grain in traditional practices hints to the greater importance that it once had in the food security and culinary traditions of Mali and West Africa and is an appealing characteristic for consumers. In Bamako, in contrast to rural areas, the cereal has generally no importance as a staple grain but it is still consumed popularly as food during feast days, for important guests, and a snack (Fogny-Fanou 2012). The grain carries a high market price in part because of its high esteem but also because of low yield and supply (Foltz 2010). The high price represents an income-earning opportunity for producers on marginal lands but also a barrier to use for cash-limited consumers.

Fonio is highly drought tolerant and grows on marginal soils with no inputs (Vall et al. 2011). Because of its capacity to thrive under low nutrient conditions, it is often the last crop in the rotation cycle before the land is left to fallow (Adoukonou-Sagbadja et al. 2006). As it requires no inputs

the cost of production for the crop is very low, which makes it an accessible income-earning and risk management strategy to resource-limited producers (Vall et al. 2011). In terms of labour, the crop is considered to be relatively low maintenance up until the harvest stage but harvest is arduous due to high seed shattering, which is most severe in the short-maturing varieties (Vall et al. 2011, Foltz 2010). In the semi-arid zone farmers often will harvest only a small patch at a time to meet short-term needs, while spreading out the intensive work for harvesting and processing over time (Vall et al. 2011).

The small size of the grain and numerous seed coats makes fonio very tedious and time consuming to process and cook (Foltz 2010). This work is the responsibility of women who must juggle their domestic and productive responsibilities and who are increasingly opting to use more convenient-to-prepare grains that have become more available. Reducing the time and labour involved in processing could be key in increasing the appeal to consume and commercialize fonio and its products.

Traditional vegetables

Increasing the use of climate-hardy crops such as Bambara groundnut and fonio can strengthen food security by ensuring greater availability of food, especially in drought years and under a contracting growing season. The nutritious properties of Bambara groundnut and fonio can also enhance diet quality bringing important micronutrients to diets dominated by few staple crops. It is acknowledged, however, that these crops cannot provide all the essential nutrients required for a balanced diet. Promoting other nutrient-dense underutilized foods such as vegetables and fruits would also be strategic to address malnutrition in the target sites.

There are many neglected and underutilized vegetable species grown and gathered by communities in Mali (Box 1) that with greater promotion can be important sources of essential micronutrients like iron, zinc, vitamin A or vitamin C. The vegetables cultivated, collected and consumed by communities will be documented early in the Project to identify species with high potential to improve nutrition, income and climate resilience of target communities.

Target sites

The study will focus on two regions of Mali: Ségou and Sikasso (Figure 1). Ségou is in the Sudanese zone that receives 400-600 mm rainfall annually and the main crops are sorghum, millet, cowpea and fonio. Sikasso is in the Pre-Guinean Zone which receives comparatively more rainfall (800-1000mm annually) and has more diverse cropping systems with the main crops being sorghum, maize, millet, cowpea, cotton and fonio.

Six villages are being targeted with the project activities: three in Sikasso region and three in Ségou region (Table 1). The total population of these villages is 10,789, with 1,703 households. Two additional villages have been surveyed, one in Ségou and one in Sikasso, with a reduced set of questions to provide a counterfactual. The treatment and control villages were selected based on similar criteria and they have socio-economic and agronomic characteristics typical of their regions. Villages where the target crops (fonio, Bambara groundnut and vegetables) are cultivated and where women are involved in income generation from these crops were selected. Willingness of the villagers to undertake activities was also an important criteria for selection of both control and treatment villages.

Bolimasso and Boumboro in Ségou region were part of a previous project by Bioversity International supporting on-farm conservation. N'Goutjina in Sikasso region was surveyed for its level of agricultural biodiversity in a previous Bioversity International Project. This project will build on these past efforts. By having a more continuous effort in these communities, there is better trust and commitment and also the possibility to leverage knowledge and capacity built through the past work.

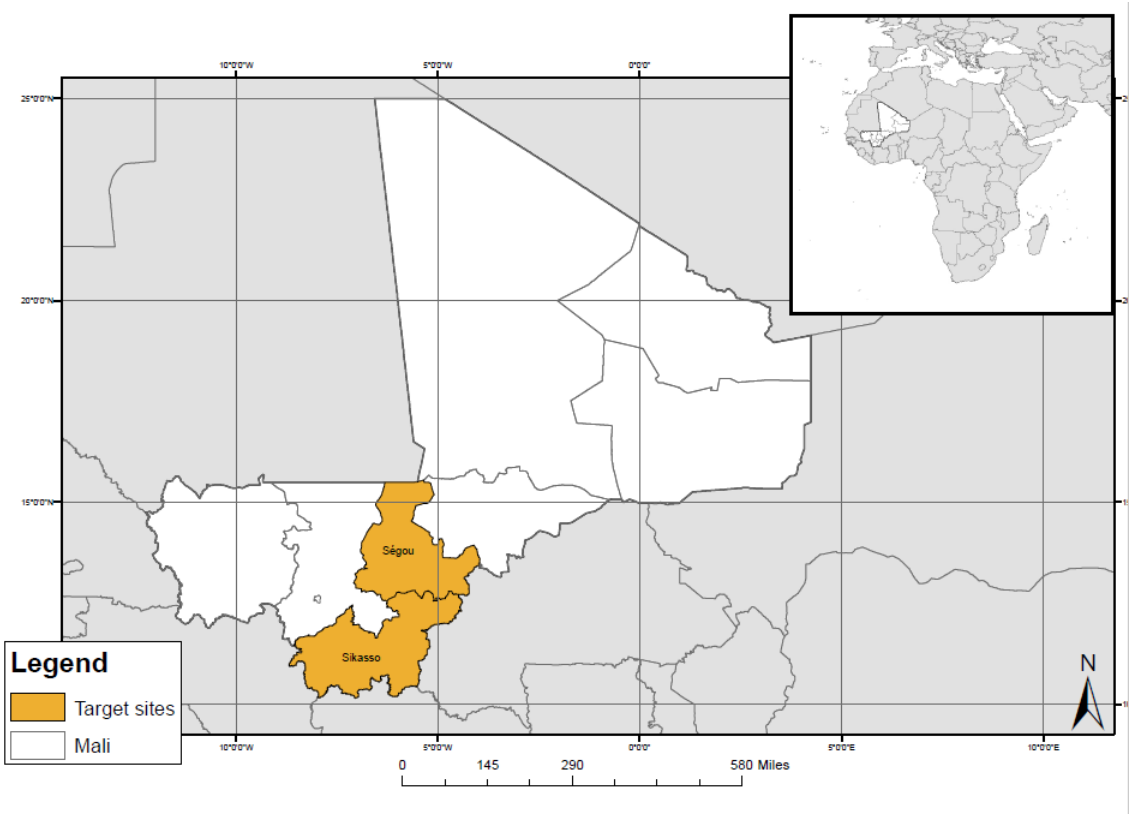

Figure 1. Target sites in Mali

Table 3. Target communities of the IFAD-EU NUS Project in Mali.

Region	Cercle	Commune	Village	Ethnicity	Pop	% Female	#HH
Sikasso	Sikasso	Fama	Siramana	*Senufo*	2127	52.1	302
	Koutiala	N'Goutjina	Finkoloni	*Miniaka*	1980	51.7	279
	Koutiala	N'Goutjina	N'Goutjina	*Miniaka*	3372	50.7	437
	Koutiala	Sincina	Kaniko*	*Miniaka*	2210	51.6	284
Ségou	Tominian	Mandiakuy	Boumboro	*Dafing*	312	51.9	46
	Tominian	Bolimasso	Bolimasso	*Bobo*	478	46.4	104
	San	Somo	Somo	*Bobo*	2520	50.6	535
	San	Somo	Boutenisso*	*Bobo*	908	50.8	199

* Control communities where only surveying will be performed

Major Activities

The IFAD-EU NUS Project will promote the cultivation, consumption and conservation of Bambara groundnut and fonio to strengthen food and nutrition security and livelihood resilience of target communities in the face of climate change. Investigations will also be made, starting with baseline household surveys and focus group discussions in the first year, to understand the current use of indigenous vegetables in target communities and identify species that could be promoted to address critical nutrition gaps and generate income for target communities.

High quality seed

The yield and consistency of production of fonio and Bambara groundnut are major constraints for their use. The Project will work to improve the production characteristics of these crops by identifying high quality varieties through participatory variety selection. Collections will be realized in the target villages and nearby villages and the seeds of at least 10-20 local and improved varieties of fonio and Bambara groundnut will be multiplied. This process will support adaptation

of the farming systems to climate change, as selected varieties may be shorter duration or more tolerant of drought, pests, disease or other pressured faced by the communities. Preferred varieties will be produced and made available to help raise productivity and the contribution of these crops to family food security and income.

Value chain analysis and interventions

A multi-actor analysis of the fonio value chain will be realized involving farmers, private sector and researchers to identify key constraints to the use of fonio and Bambara groundnut that should be addressed in the Project. The washing step, which uses a large amount of water and may be the key step responsible for loss of iron content, is an area we would like address, but there may be other steps identified in the analysis that are more relevant to the target communities. The value chain analyses carried out with multiple stakeholders research will investigate the viability and effectiveness of promoting Bambara groundnut and fonio, as opposed or in addition to other underutilized native crops, to achieve the Project aims.

The capacity of existing farmers' networks or associations will be strengthened and the creation of new associations and networks will be encouraged as required. The capacities of these associations will be strengthened through training on best practices in production and processing of the target crops (post-harvest activities, threshing and shelling, steaming food technology, fortification, and packaging).

The organization of the market sector, pricing mechanisms and market information systems for target crops will be studied. Farmers access to information on the market will be enhanced, which along with access to agro-meteorological information, will support farmers' decision-making processes.

Women's Empowerment

Bambara groundnut is a crop typically cultivated by women. The gender roles in fonio cultivation are more variable. In Ségou region fonio is grown on communal plots controlled by men (Sogoba et al. 2013), while in Sikasso region it is commonly grown by women on their individual plots (Collins & Foltz 2013). In any case, the processing of both crops is the responsibility of women and is highly time consuming and labour intensive, which is a barrier to increasing the use of these nutritious and hardy species. Previous value chain development projects implemented in Mali have supported women's groups in purchasing fonio from male dominated producer associations and processing it for commercialization, mainly in local markets (Sogoba et al. 2013).

The holistic value chain approach taken in the Project will support various dimensions of women's empowerment. It will contribute to raising the income (financial capital) that comes under women's control, by enhancing the value-addition and marketing of the target crops in a context where income streams are gendered and where women's income can be 3-4 times smaller than men's (McGlinchy 2006). It will also focus on increasing women's decision-making and leadership in the community and their social capital by strengthening collective action via consolidation of crop processing groups. Training on best cultivation and processing methods and provision of new and adapted tools (physical capital) for cultivation, harvesting and processing will enhance yields, reduce drudgery and save time in processing. Women's capacities (human capital) to produce high quality products and run collective enterprises - skills which can be applied to the pursuit of other livelihood activities - will additionally be enhanced through a range of capacity strengthening initiatives.

Conservation

Sustainable agricultural value chains and production systems depend on availability of quality genetic resources and seed. Actions will be taken in the Project to conserve the genetic diversity of minor millets to ensure continued availability and adaptability of materials in a changing climate.

The Project will support the creation of community seed banks where they do not already exist and it will strengthen the capacity of existing community banks. Seed fairs will be organized to

encourage exchange of seed, share information, improve the linkage between villages and sensitize people on the importance of agricultural biodiversity.

An inventory on threatened and/or extinct species and varieties, especially for target species will be established using the five cell analysis. A red list will be compiled based on this initial inventory and confirmed by assessing the presence of varieties in the communities and the region.

Community biodiversity registers will be established in villages where they currently do not exist and where they have already been established, the Project will encourage them to be updated. The possibility to take advantage of a fellowship program for rural people in Segou and Sikasso will be explored. Seed fairs will be organized as an important occasion for different actors to exchange seeds and knowledge.

Traditional and novel practices for managing climate risks

In West Africa, farmers and fishermen have developed a wealth of knowledge and a great flexibility to manage environmental fluctuations. This knowledge is a resource that must be protected, applied and enhanced. Traditional agriculture in Mali involves practices to conserve water resources by avoiding water runoff, such as the Zaï practice, contour ploughing, and ploughing cycle end, which are practices that also support soil conservation.

Recognizing that rural communities are repositories of important knowledge to sustainably manage resources and adapt to changes and risks that affect their food security, the Project will document and support this knowledge, especially focusing on the role of agricultural biodiversity in these strategies. The Project will promote the recovery of traditional practices, where they can be favourable against the negative effects of the climate changes. New methods and approaches used by other communities and researchers will also be shared to improve productivity and encourage adaptation of farming systems to changing conditions. An inventory of traditional and modern practices will be made and those most relevant for the local context will be identified through a participatory process. Training will be provided to farmers on practices for adaptation to climate change, including practices using the target species, where farmer field fora will be promoted as a collective learning process between researchers, developers and farmers. Resilience-building activities, such as exchange of seed, will be emphasized.

Lobbying for supportive policies

Policies can be key in realizing or hindering the benefits of fonio and Bambara groundnut and other indigenous crops for nutrition, income, climate resilience and empowerment of women. A study will be made on seed usage policies of local varieties of targeted crops and opportunities to increase their consumption/use through positive changes in seed legislation and other forms of legislation (health, education, and environment). The Project will develop policy options that encourage better use through the connection between community banks and the national bank, encouraging multifaceted cooperation between actors and groups of actors. It will also work to strengthen dialogue between stakeholders through meetings with key partners on the role of target crops.

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