



Dual purpose sorghum and cowpea intercropping in Mali

Introduction

In Mali, agriculture is the main source of employment. Over 80% of the population is engaged in agriculture that is mostly carried out by small farmers with income of less than US\$1 per day. Sorghum (*Sorghum bicolor* (L.) Moench) is an important cereal grain used as food and animal fodder (dual-purpose sorghum). Sorghum is predominantly grown in sole or in mixture with cowpea, peanut or maize in the Sudanian zones where the annual rainfall is comprised between 800mm and 1000mm. The main constraints to sorghum production are low soil fertility and low and erratic rainfall exacerbated by climate change.

Animal production represents 10% of the GDP. It is the main resource for 30% of the population (Elevage au Mali, 2004). The main constraint to animal productions is the limited availability of suitable feeds. Especially in the dry season, the nutritive value, the protein content and dry matter intake of range-land forages are very low. Legume residues are needed to complement proteins provided by cereal straw. Cowpeas for dual grain and fodder use are increasingly being demanded by farmers. So far, no agronomy research has been undertaken specifically to optimize value of grain and fodder in sole or intercrop sorghum-cowpea systems. Therefore, research has been conducted under the project “Dual-Purpose Sorghum and Cowpeas: Opening the Window for Crop-Livestock Intensification by Combining Grain and Improved Crop Residues”, which is financed by the Collaborative Crop Research Program (CCRP) of the McKnight Foundation.

Grain sorghum producers and their organizations are the ultimate end users of the results of this research, as they are the main beneficiaries. Different social classes of producers were included in the baseline study and the implementation of the project activities including the poorest, the middle ones and the rich ones. In these communities, sorghum is the main staple food consumed as porridge and in other local meals. Many farmers are classified as agro pastors, because of their involvement in both crop and animal production activities. One of the most important aspects of dual purpose sorghum research is the satisfaction of both crop and animal production needs.

Dual purpose sorghum leaves remain green until physiological maturity. They are characterized by short internodes and improved digestibility. Improving animal nutrition and production will also improve crop productivity and income through increased animal health, working power and increased access to quality manure. In addition to crop and animal producers, food technologists and animal nutritionists are also important beneficiaries of this project. Sudanian zones offer the most favorable growing environments for grain sorghum production in Mali. It is also the region where animal traction is heavily used for farming activities and where more and diversified intercropping are practiced.

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Figure 1. Women harvesting cowpea in a dual-purpose sorghum cowpea intercrop field



These are some of the reasons justifying the site selection operated in this project. The results of this project will likely go beyond Mali and benefit grain sorghum producers in similar agro climatic conditions in West Africa.

Three sites were selected in the Sudanian zones of Mali for on farm evaluation. Two of the sites Koutiala in the Sikasso region and Dioila in the Koulikoro region were selected for the importance of land pressure due to very long term cotton cultivation and intensive use of animal traction. The third site selected is Kita in the Kayes region for its relatively low pressure on land. In each site four villages were chosen and in each village ten men and women producers were selected from different socioeconomic contexts.

The site selection was a participatory process involving researchers, extension specialists, farmers, farmers' organizations and unions' representatives. Technical and agronomic reasons behind the site selection were focused on both extensive and intensive land uses as a result of long term cotton cultivation. This implies extensive land exploitation and intensive use of draft animals for various farm operations. The cotton production zones in Mali are not the poorest zones in the country. However the socio-economic criteria used to classify the producers involved in the implementation of the project were based on the access to resources. These criteria included the type and number of equipment owned and used by the farm unit, the number of draft animals used in farming and the number of active members of the household involved in farming activities. The partitioning of farmers in the three socio-economic classes in each village was completely done by farmers themselves in a focus group meeting in collaboration with research personnel.

Description of the Agroecology system

A study on dual purpose sorghum genotypes was conducted at the Sotuba Research Station near Bamako (Mali) and in three sites in the Sudanian zones of Mali. The study included two dual purpose sorghum genotypes (one improved variety obtained from the Institute of Rural Economy-IER- and a hybrid from International Crops Research Institute for the Semi-Arid Tropics-ICRISAT) compared to a local sorghum genotype. The dual purpose sorghum is a grain sorghum genotype producing sufficient quality grains for human consumption and fodder for animal feed. It is proven to be more digestible by animals than local sorghum varieties. Dual purpose cowpea is a cowpea genotype having good grain and fodder production potential. Intercropping is chosen because it is a land saving technology or strategy in an environment where good cropping land is more and more scarce. The soil coverage offered by cowpea crop reduces evaporation, soil erosion and conserves soil humidity.

The three sorghum genotypes included 1) local variety: Tieble; 2) hybrid variety: Fadda; 3) improved variety: Tiandougou Coura. Fertilizer levels included: 1) no fertilizer application; 2) microdose alone; 3) manure combined with microdose; 4) 41-46-0 NPK formula of 100kg/ha of DAP and 50kg/ha of urea. Dual purpose sorghum and cowpea intercropping system included: 1) alternate single rows; 2) alternate double rows. To cope with low soil fertility, low access to improved sorghum seeds as well as a poor integration of dual purpose cowpea in dual purpose sorghum production systems, a factorial experiment was designed to evaluate the effects of dual purpose sorghum genotypes (3), fertilizer application(4) and the manner of intercropping of dual purpose sorghum and cowpea(2). There was a total of 24 treatments. Only a sample (2 x 2 x 2) of the total treatments was evaluated at the farm level.

The traditional system of Intercropping or mixed cropping of cereals and legumes is a major production system in Mali. In these systems, sorghum and cowpea seeds are mixed and planted in the



same hill. Inter-specific competition is very important in these mixed cropping systems as it results in low yields of the component crops. Alternating rows of sorghum and cowpea contributes to reduce inter-specific competition and increases sorghum and cowpea yields in this intercropping system.

The project is proposing different options to tackle different production constraints in different contexts. Farmers are willing to choose the options that better fit their socio-agronomic contexts. Both the feasibility and profitability of these options are evaluated in a participatory process with the different producers involved in the study. Some of the findings reported by these collaborators are investigated further. For example, farmers from Koutiala and Dioila sites indicated during the last restitution meeting that the porridge made from the improved variety (Tiandougou Coura) proposed in the study can help breastfeeding women by improving milk production. This has to be assessed by food technologists this year before drawing any conclusion.

Outcomes of the practices

The sorghum hybrid Fadda and the improved variety Tiandougou Coura had significantly higher yields than the local variety Tiéblé. The greater performance of these two genotypes compared to the local varieties was confirmed on farm evaluation in the three sites. They have also been appreciated and accepted for food for the population as well as feed for animals. In addition a new market for sorghum straw is developing around these new sorghum genotypes. Considering that large quantities of dual purpose sorghum straw can be produced, this will contribute to improve the overall performance of the cropping system. According to many producers in the Kita site, the production of the improved variety Tiandougou Coura has improved their livelihood.

Cowpea yield was important (around 1 t ha^{-1}) under the three genotypes in general and particularly under Tiéblé (1.2 t ha^{-1} , Figure 2). These results indicate that there is a tradeoff between sorghum and cowpea yields. Cowpea is considered as a cash crop in the system. Its price is 2 to 3 times higher than that of grain sorghum. In addition cowpea fodder is very much appreciated as animal feed. In the Beleco zone (Dioila site), the producers' union has organized women and men around the intercropping of dual purpose sorghum and cowpea production for marketing of the products. Through this organization 80 tons of cowpea grain and 1000 tons of sorghum grain were produced. This has been a real success story in the community.

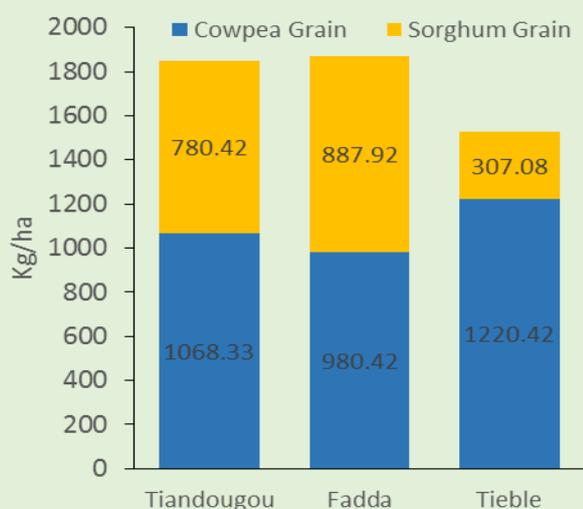


Figure 2. Dual purpose sorghum and cowpea yield (kg/ha) in intercropping, Sotuba, 2014-15

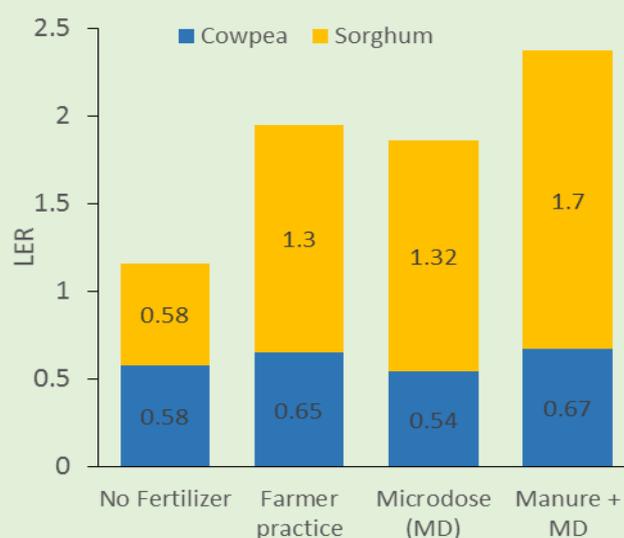


Figure 3. Fertilizer effects on sorghum/cowpea intercropping performance in terms of Land equivalent ratio (LER)



The Land Equivalent Ratio (LER) of the hybrid Fadda was higher than that of Tiandougou Coura. The third genotype Tiéblé was completely destroyed by birds. Partial LER for the grain yield of the two remaining genotypes were all greater than one, indicating a better performance of sorghum in intercropping than in monoculture. LER was positively influenced by fertilizer application (Figure 3). Farm manure combined with microdose application resulted in greater LER than the other treatments. Alternate arrangement of two rows of sorghum and two rows of cowpea showed greater LER than alternate single rows.

Advantages

- Good soil cover, provided by cowpea in the system, contributes to reduce soil evaporation;
- Alternate rows of sorghum and cowpea also favour the penetration of light into the canopy;
- The legume contributes to improve the nitrogen status of the soil;
- Different rooting systems of grain sorghum and cowpea contribute to reduce the inter-specific competition for nutrients.

The results of the study indicate a better performance of the sorghum hybrid Fadda in intercropping, compared to the other genotypes. Intercropping of sorghum and cowpea was more productive than the monoculture of sorghum. Crop management had a positive effect on the overall performance of the intercropping system. Better land saving technology contributes largely to improve crop productivity and sustainability. It will also contribute to reduce social conflicts between producers and pastoralists linked to a specific community land.



Figure 4. Exchange visit by producers to the experimental plot in Sotuba, Bamako, November, 2015

Message from farmer to farmers

"My message is clear and simple: the new cropping system combining dual purpose sorghum and cowpea has been developed specially to help sorghum growers. Truly it has changed my life. In fact it allows to:

1. increase grain and straw productivity;
2. increase food security;
3. increase incomes through cowpea grains and fodder sale as well as dual purpose sorghum grain and straw sale.
4. it's only with dual purpose sorghum varieties that farmers can produce and sell large quantities of straw and make good profit."

—Message from Mr. Diango Coulibaly, farmer from the Kita site



Figure 5. Mr. Diango Coulibaly (second row) during an exchange visit to similar experiment in the Kita site, Oktober, 2015