Baseline characterization of the local stakeholders to promote the uptake of sustainable intensification of cereal-based farming system innovations in the Sudano-Sahelian zone of Mali

Produced by

Joachim Nyemeck Binam, Catherine Dembele, Bougouna Sogoba,

With the contribution of

Adama Diakite and Arouna Bayoko

Draft

Background

The determinants of the uptake of sustainable intensification-related technologies in sub-Saharan Africa have been extensively researched and various factors identified and classified under four broad categories, namely, socio-economic, institutional, technical, and political (McCulloch et al., 1998; Boyd et al., 2000; Mbaga-Semagalane and Folmer, 2000; Drechsel et al., 2005; Sidibe, 2005; Loeffen et al. 2008). While the identified determinants undoubtedly contribute to low rates of adoption, albeit with varying magnitude, one of the constraints that has received widespread acceptance as the major hindrance to adoption of improved technologies in sub-Saharan Africa in recent literature is the approaches that have been used to develop and disseminate these technologies (Oehmke and Crawford,1996). In an attempt to improve the levels of uptake of improved technologies in sub-Saharan Africa, the region has witnessed a number of paradigm shifts in its agricultural research and development arena. Some of the approaches that have been tested and implemented include Farming Systems Perspective (FSP), participatory research methods, Agricultural Knowledge and Information Systems (AKIS), Rural Livelihoods, Agri-food Value Chain, Knowledge quadrangle, Double Green Revolution, Rainbow Revolution, Innovation Systems Perspective and Positive Deviance approach. Nevertheless, adoption rates have not improved by reasonable margins. Besides, the impact of adoption of the technologies developed and disseminated through the aforementioned approaches on welfare and productivity indicators have only been marginal (Renkow and Byerlee, 2010). More importantly, these approaches have been under heavy criticism for their inability to tailor the technologies to the needs of smallholder farmers in sub-Saharan Africa who are more often than not confronted with difficult situations including vagaries of weather. In particular, the conventional approaches have been criticized for failing to internalize external factors that hinder the adoption of improved and sustainable intensification technologies.

In a bid to bridge the vacuum that has been created by the conventional approaches, the most recent paradigm shift in agricultural research and development has been towards the recognition

of research, technology transfer and technology use as a single entity rather than independent activities where technology development and technology transfer flow linearly from researchers to farmers through extension agents. This recent approach, known as Integrated Agricultural Research for Development (IAR4D), was developed and actually widespread in Sub-Saharan Africa by the Forum for Agricultural Research in Africa (FARA) through extensive consultations with various agricultural stakeholders, including researchers, extension and development agents, policy makers, farmers and the private sector (FARA, 2008). Therefore, IAR4D aims to mitigate through innovation platforms (IPs) external factors that constrain adoption of improved technologies by establishing and strengthening institutional linkages among farmers and key stakeholders along the value chain and/or the system, with a view to improving efficiency and welfare outcomes.

The Sustainable Intensification of Cereal-Based Farming Systems in the Sudano-Sahelian Zone; a USAID funded project in Mali under the auspices of the Africa research in sustainable intensification for the next generations (Africa RISING), is willing to create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. This is intended to be achieved through four operational work packages (WP) including: (1) community mobilization and innovation platform WP, (2) improving farm and field productivity and profitability WP, (3) managing natural resources to increase watershed productivity WP and, (4) nutrition and value addition WP.

This characterization study is carried out under the innovation platform work package and aims to: (1) identify and characterize the existing stakeholders involved in agricultural development, (2) assess the level of interaction among different stakeholders so that we identify gaps needed to be filled to better establish and strengthen institutional linkages and networks among different actors in the system in order to foster awareness and adoption of improved sustainable

intensification technologies as posited by the proponents of research for development (R4D) platforms.

Methodological framework

Networking and the diffusion of innovations

The existing literature on the determinants of technology adoption demonstrated that among the factors that affect adoption of agricultural innovations, social factors play an important role (Valente and Rogers, 1995; Boyd et al., 2000; Mbaga-Semagalane and Folmer, 2000; Drechsel et al., 2005; Sidibe, 2005; Loeffen et al. 2008). One form of incorporating such factors is based on the knowledge sharing and learning among stakeholders (Acemoglu et al., 2008; Jackson, 2008; Oduol et al., 2011). Thus bridged the analysis further in explicit network perspective on innovation. According to Valente (1999), within such networks social processes occur that impact the way individuals learn and react with regard to the adoption or non-adoption of an innovation, a concept qualified as "*contagion*".

There are also some theories that are important to explain the diffusion process. One important approach within social network theory that tries to explain the phenomenon of earlier adopters or innovators is strength and weak ties (SWT) theory (Granovetter, 1973, 1983). Actors interact with others and disseminate their idea about innovations, consequently, it is possible to determine who influences whom. Theoretically, the power dynamic can affect our own ideas and decisions since the spread of ideas flows through social interaction networks.

In social network, the nodes represent social actors, often individuals. The social network is then represented by the graph **F**, with **A** nodes and **T** edges, $\mathbf{F} = \{\mathbf{A}, \mathbf{T}\}$**.** Formally speaking, network structure is the pattern of edges between such nodes that can be directed or undirected. Formally speaking, network structure is the links of edges between such nodes (Carrington et al., 2005). Links can be undirected ("shares information with") or directed ("seeks advices from"). Directed links can be one-way or two-ways. The most fundamental network configurations is

directed networks between two (*dyad*) or three nodes (*triad*). The case of dyad mutually may represent a restricted exchange of resources or information, while the three-cycle may represent a more generalized exchange in substructures larger than a dyad, where no prompt reciprocity is necessarily required (Scott, 2000).

Density is the number of links that exist in a network divided by the possible number of links that could exist in the network. Generally speaking, density helps to define clusters: a cluster being a local region in a network with relatively high density and few links to other clusters (for more details see Brandes and Erlebach, 2005).

Bridging and bonding are very important concepts of network analysis (Hope and Reinelt, 2010) and define two kind of connectivity. Bonding denotes connections in a tightly knit group, while bridging denotes connections to diverse others. Borrowed from the social capital, bonding and bridging are often called in the social network literature “closure” and “brokerage” respectively (Burt, 2015). Analyzing network data to measure bonding and bridging helps to predict important outcomes such as efficiency and innovation: bonding indicates a sense of trusted community where interactions are familiar and efficient, while bridging indicates access to new resources and opportunity for innovation and welfare (Burt, 2005). The extent to which bonding or bridging occurs in a network often represents an intermediary outcome of leadership development. Finding bridgers in a network is typically done with the calculation of called betweenness centrality that indicates how often one individual is likely to be an important relay point between other network members. Another measure use to find bridgers is network constraint (Burt, 2004; 2005) measuring the extent to which an individual links to others that are already linked to each other. Low network constraint means that an individual has links to others who are not already linked to each other. High betweenness centrality and low network constraint both indicate bridging.

Hubs are individual in the network with the most influence. Hubs of influence in a network are best measured using directed links. Given a network of directed relationships, indegree centrality counts how many relationship point towards and individual which provides a simple measure of

influence (Freeman, 1979). A person whose advice is sought by someone who is highly influential may have a higher influence score than one whose advice is sought by non-influencers.

Sample description

Four different tools were developed and the questionnaires were directed toward key respondents. The tools focused on the following:

- Stakeholder inventory in Bougouni and Koutiala
- Identification of critical main agricultural issues faced by the selected stakeholders
- Analyzing stakeholders interest and influence on the critical issues
- Mapping stakeholder characteristics and interactions.

In addition to the private institutions targeted, the following governmental institutions were considered:

- Agriculture,
- Health,
- Social development,
- Water and Forest unit,
- Meteorological department

From these exchanges, a set of information were compiled on rainfall, temperature, population and farming systems.

For the second tool (inventory of stakeholders intervening in the region/sites) information were collected from AMASSA (Association malienne pour la securite et la souverainete alimentaire) and the Agricultural Chambers where the farmer's organizations are registered.

Concerning the tools C and D, the following NGO and community-based organizations (CBO) were interviewed:

AMEDD (Association malienne d'eveil pour le developpement durable)

- AMASSA,

- COPAM (Centre commercial des produits agricoles du Mali) and six farmers organisations:
- UFROAT (Union des femmes rurales ouest africaines et du Tchad)
- UCPTC (Union des cooperatives des producteurs et des transformateurs de cereales)
- ULPP (Union locale des pepinieristes et planteurs)
- ULCFBV (Union locale des cooperatives de la filiere betail et viande)
- ULCMK (Union locale des cooperatives maraicheres de Koutiala)

Information gathered in Bougouni

The same official departmental offices were visited to gather information needed for biophysical and socioeconomic characterizations. In addition MOBIOM (Mouvement biologique du Mali) and the "Coordination des ONG de Bougouni" assisted to gather information on the existing stakeholders in the region. The remaining forms were filled through the support of the following organizations:

- BACIR (Bureau d'appui conseil aux initiatives rurales)
- CORIMA (Cooperative des riziculteurs et maraichers)
- CJR (Cooperative des jeunes ruraux)
- CSE (Cooperative syndicat des eleveurs)
- Dalabani (Cooperative semenciere nationale)
- Balimaya (Cooperative agricole)
- CAALCOP
- COFPROSOTRANS (Cooperative feminine pour la promotion du soja et la transformation des produits agro-alimentaires locaux).

Stakeholder inventory

The main objective of this was to record all organization, external and internal working within the site in the areas of agriculture and development.

The external (i.e. non community-based organizations) and internal organization and institutions identified in Koutiala and Bougouni covered the following:

- Farmer groups and organizations;
- The National agricultural research and extension services (NARES);
- NGOs and other project implementing organizations, and;
- Local policy institutions.

Table 1: External organization identified in Koutiala

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	AMASSA	NGO	Community mobilisation	Capacity building farmers on agricultural innovations	On-farm plots demonstration
2	AMEDD	NGO	Community mobilization	Capacity building of farmers on agricultural innovations	Natural resource management
3	Decentralized Agricultural service	Extension department	Community mobilisation	On-farm demonstration of technologies	Capacity building of farmers
4	Health Centre	Health department	Heath		
5	Chamber of Agriculture	Community office	Community mobilisation	Marketing	
6	Decentralized water and forest service	Extension department	Natural resource management	Sensitization	Policy and regulations
7	Social development service	Social service	Community mobilisation	Sensitization	
8	The Local council	Community office	Community mobilisation	Sensitization	Policy

Table 2: Farmers organizations identified in Koutiala

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	Association des veuves 'Allah makono'	Community women-based organization	Crop production		
2	CMRN	Mixed groups	Crop production	Commercialization of agricultural products	
3	Cooperative agricole TAGO	Community men-based organization	Crop production	Commercialization of	

				agricultural products	
4	UCPTC	Mixed group	Crop production	Natural resource management	Commercialization of agricultural products
5	Association des femmes de Sirakele	Community women-based organization	Crop production	Commercialization of agricultural products	
6	ULCGRN	Mixed groups	Crop production	Natural resource management	
7	ULPP	Mixed groups	Crop production	Natural resource management	
8	ULCFBV	Mixed groups	Crop production		
9	ULCMK	Mixed groups	Crop production	Vegetable farming	
10	UFROAT	Community women-based organization	Crop production	Vegetable farming	
11	ULMB	Community men-based organization	Natural resource management	Commercialization of agricultural products	

Table 3: External organization identified in Bougouni

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	AMEDD	NGO	Community mobilization	Capacity building of farmers on agricultural innovations	Natural resource management
2	Coordination des ONG locales	NGO	Community mobilisation		
3	Decentralized Agricultural service	Extension department	Community mobilisation	On-farm demonstration of technologies	Capacity building of farmers
4	Decentralized water and forest service	Extension department	Natural resource management	Sensitization	Policy and regulations
5	Meteorological service	Extension department	Weather	Agricultural information support	

6	Livestock production service	Extension department	Community mobilisation	Dissemination of innovations	Farmer training
7	Chamber of Agriculture	Community office	Community mobilisation	Marketing	
8	Health Centre	Health department	Heath		
9	Social development service	Social service	Community mobilisation	Sensitization	
10	The Local council	Community office	Community mobilisation	Sensitization	Policy

Table 4: Farmers organizations identified in Bougouni

No.	Name of organization	Type of organization	Type of activities 1	Type of activities 2	Type of activities 3
1	MOBIOM	NGO	Crop production	Natural resource management	Commercialization of agricultural products
2	COPROSOTRANS	Women-only groups	Crop production	Commercialization of agricultural products	
3	Cooperative BENKAN	Mixed groups	Natural resource management	Commercialization of agricultural products	
4	CAALUCOP	Women-only groups	Crop production	Commercialization of agricultural products	
5	Cooperative Missiba Nono	Men-only groups	Crop production		
6	Cooperative des jeunes ruraux	Men-only groups	Crop production	Natural resource management	Commercialization of agricultural products
7	Cooperative des agro dealers	Men-only groups	Crop production	Commercialization of agricultural products	
8	Cooperative de Kologo	Mixed groups	Crop production		
9	Cooperative Dunkafa de Mena	Mixed groups	Crop production		
10	Cooperatives des producteurs cerealiers	Men-only groups	Crop production		
11	Cooperatives des riziculteurs et maraichers	Mixed groups	Crop production	Epargne	Commercialization of agricultural products
12	Cooperative Sougouba	Mixed groups	Crop production		

For the external group of institutions, the main field of activities relates on: community mobilization, sensitization on critical issues, capacity building of farmers and development agents on agricultural innovations, natural resource management, public health, policy and regulations, as well as on farm plot demonstrations.

The community-based organizations are generally gathered around activities related to crop production, natural resource management and commercialization of agricultural and agroforestry products.

In both cases, the missing institutions that can play an important role within the IPs are traders, input suppliers, agro-dealers and marketing actors. It will be necessary to identify representatives of those actors while operationalizing the R4D platforms at different levels in Koutiala and Bougouni.

Analyzing stakeholder interest and influence on the critical issues

Figure 1a: Issue 1: Lack of training on team leadership and management of organization: importance and the influence the stakeholders can have in dealing with (Koutiala)

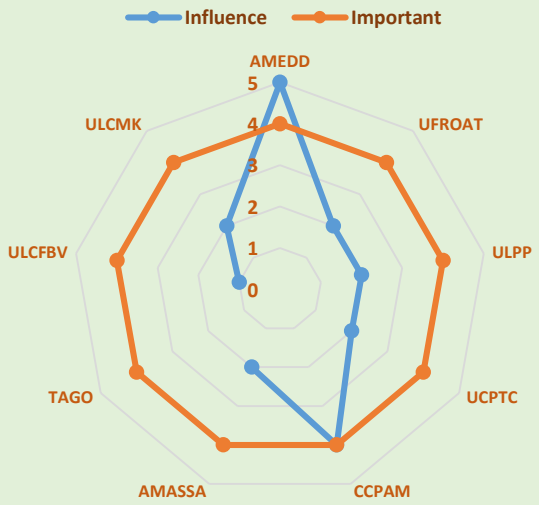
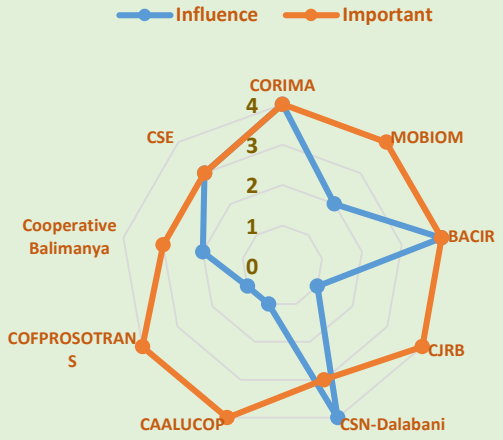


Figure 1b: Issue 1-Lack of training on team leadership and management of organization (Bougouni)



A problem tree exercise to define the key issues, the causes and effects as perceived by each cluster of stakeholders was undertaken to get different perceptions on which stakeholders are prime movers in the system as well as their relative strength of influence.

The summary of information gathered from different stakeholders are presented in the spider diagramme (figure 1 to 4) both in Koutiala and Bougouni.

Four main issues were defined to be very critical for a better development of their activities. The defined problems constraining a better implementation of their works are among others:

- Lack of training in team leadership and management of organizations;
- Ineffective access to appropriate inputs and credit;

Figure 2a: Issue 2: Access to iputs and credit (Koutiala)

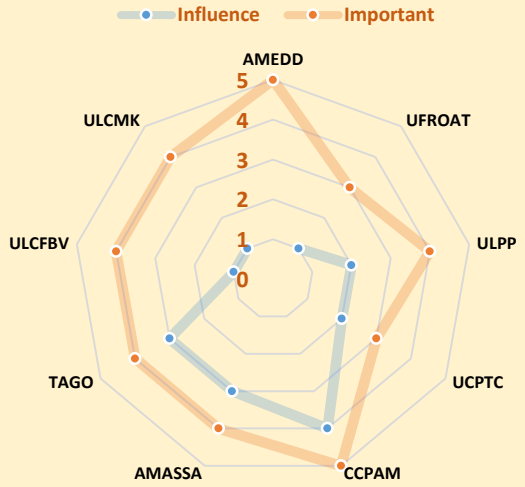
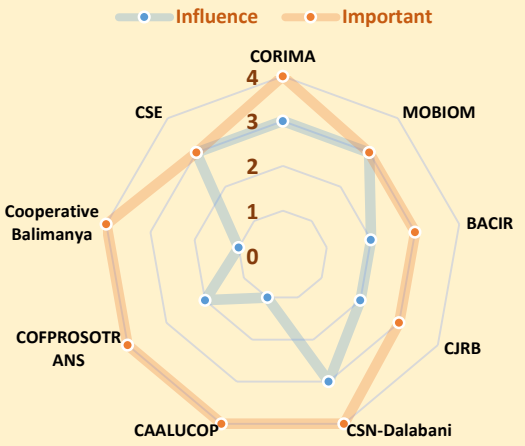


Figure 2b: Issue 2-Access to intrants and credit (Bougouni)



- Inefficient marketing of agricultural products, and;
- Lack of coordination/interactions among support services.

In order to deal with the first issue related to training on team leadership and management of organization, it is very important to involve all identified stakeholders in the process, this can be done through a capacity building on group dynamics and team leadership with additional focus on management. This can be facilitated by AMEDD and Centre Commercial des Produits Agricoles du Mali (CCPAM) who seem to have a stronger influential power on the issue. They might play a critical role on the platforms in Koutiala. The situation looks a bit different in Bougouni where Cooperaitive des Riziculteurs et Maraichers (CORIMA), Bureau d'Appui Conseil aux Initiatives Rurales (BACIR) and Cooperative Semenciere Nationale Dalabani (CSN-Dalabani) have been identified as the most influential stakeholders that can facilitate the process of dealing with such issue. There is an avenue to achieve this through their active participation in the different platforms that are being established in Bougouni cercle within the framework of Africa RISING project and others.

Figure 3a: Issue 3-Marketing of agricultural products (Koutiala)

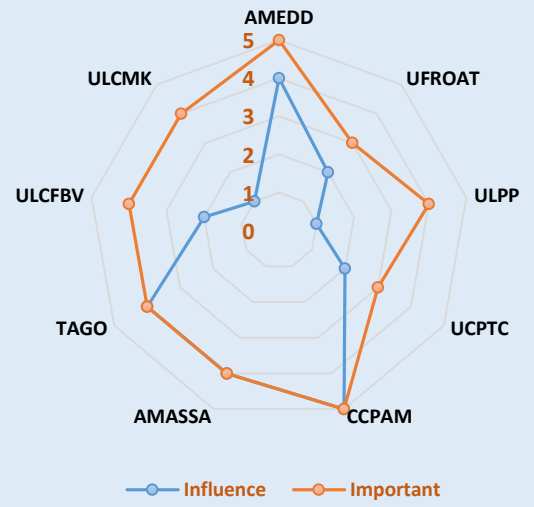
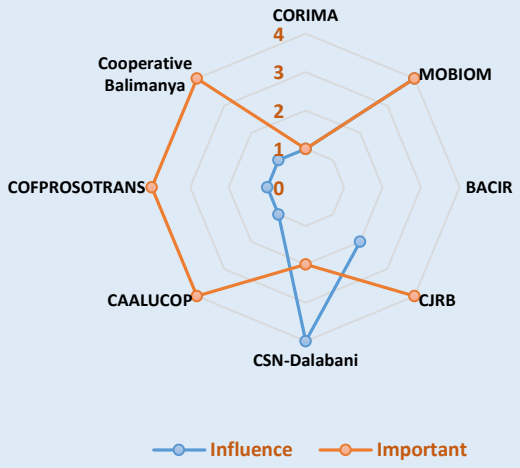


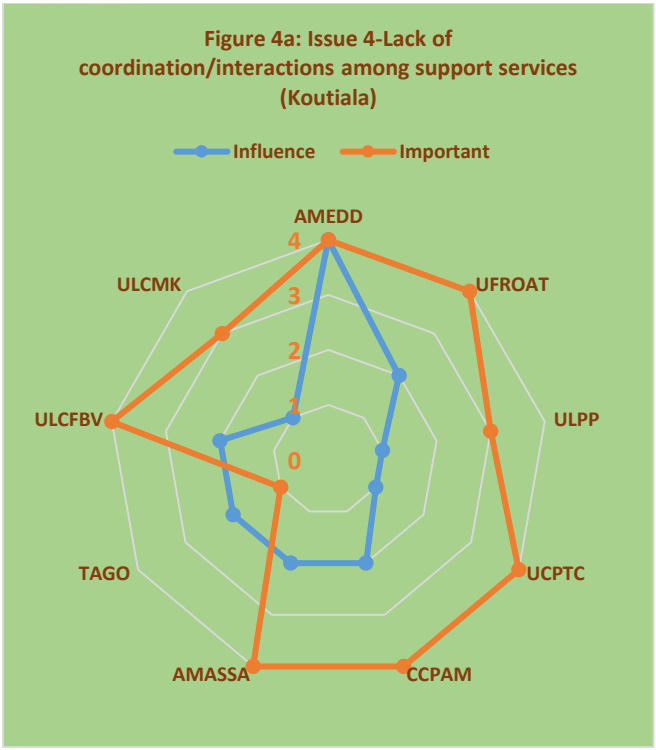
Figure 3b: Issue 3-Marketing of agricultural products (Bougouni)

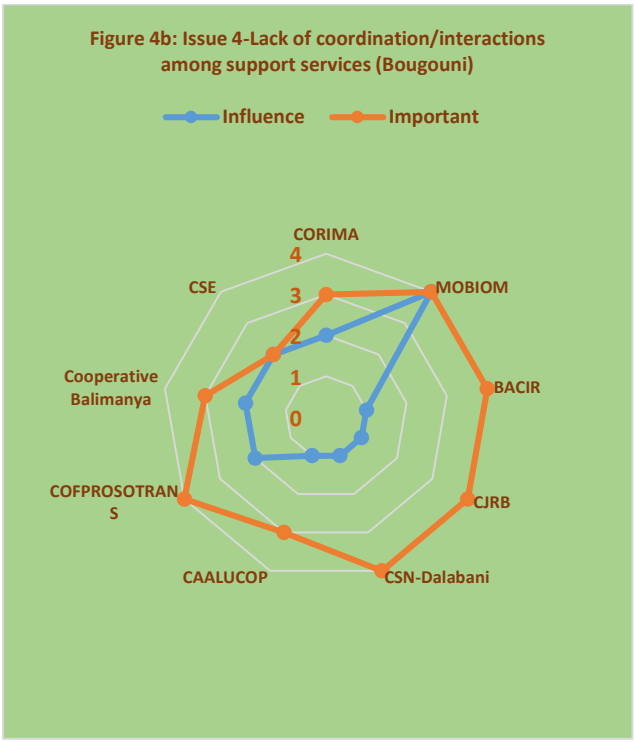


The accessibility and affordability of appropriate inputs and credit is the second issue face by many stakeholders while implementing their working plans. To address this issue, there is a need to engage the identified stakeholders in a close and sustainable linkage with input dealers and microfinance institutions. R4D platforms can be a better avenues to make this effective both in Koutilala and Bougouni.

As such, Centre Commercial des Produits Agricoles du Mali (CCPAM), Association malienne pour la Securite et la Souverainete Alimentaire (AMASSA) and TAGO seem to be the more influential organizations that can significantly impact the issue. They might be very critical actors by playing the role of Bridgers within the platforms in Koutiala.

Meanwhile, Cooperative feminine pour la promotion du soja et la transformation des produits agroalimentaires (COFPROSOTRANS), MOBIOM and Cooperative Semenciere Nationale Dalabani (CSN-Dalabani) can play the same role in Bougouni.





Marketing of agricultural products remains a major challenge in many countries including communities in Koutiala and Bougouni who stressed this as being a very important issue jeopardizing their livelihoods. The characterization of stakeholders shows that to address effectively this issue, it is important to involve most of the stakeholders engage in agricultural activities and rural development in a sustainable transformation process focuses on efforts directed by firms towards enhancing total value while reducing supply chain costs, without compromising the environmental and social/ethical dimensions of sustainability.

This can be better performed through community-based Innovation Platforms (IPs). A multi-stakeholder dialogues facilitated by support organizations to help increase awareness and recognition that commitment and communication are essential to help smallholders benefit from value chains.

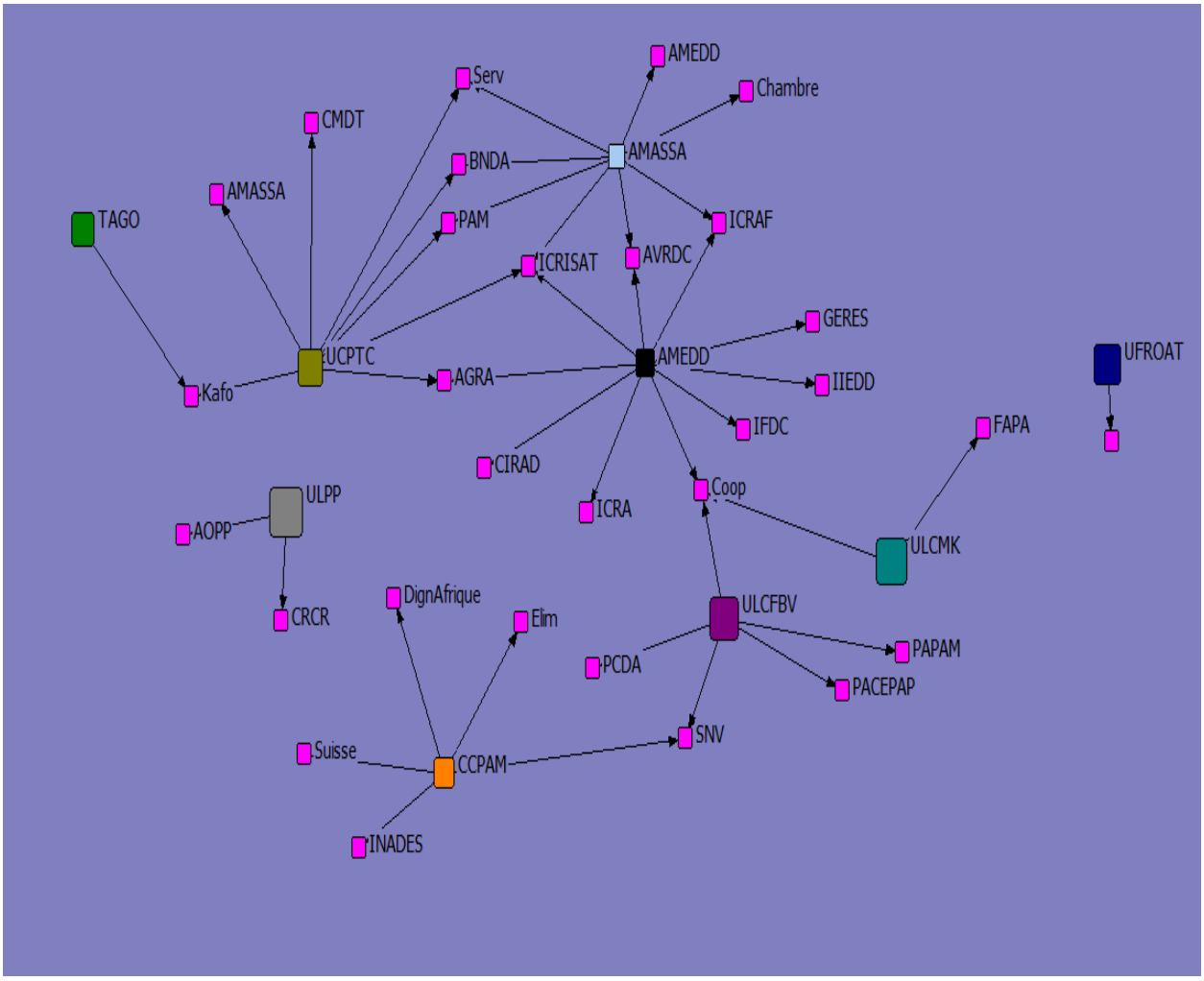
AMEDD, Centre Commercial des Produits Agricoles du Mali (CCPAM) and TAGO can bridge the networks in Koutiala by facilitating sustainable interactions between different type of actors involved in agricultural products value chains, while Cooperative Semenciere Nationale Dalabani (CSN-Dalabani) can play the same role in Bougouni. Indeed, bridging indicates access to new resources and opportunity for innovation and welfare (Burt, 2005).

Finally, the characterization also highlighted the lack of coordination/interactions among support services as being an important issue indicating that there is a need to take some actions to address this. It is clearly appearing that AMEDD in Koutiala and MOBIOM in Bougouni look like hubs i.e organizations in the network with the most influential power to deal with the issue. Consequently, their involvement in the different platforms must be critical.

Results of the network analysis

The main objective of this analysis was to map current interactions of the stakeholders, the types and intensity of these interactions, and to get stakeholders to analyze their innovation capacity.

Figure 5: Collaboration network in Koutiala

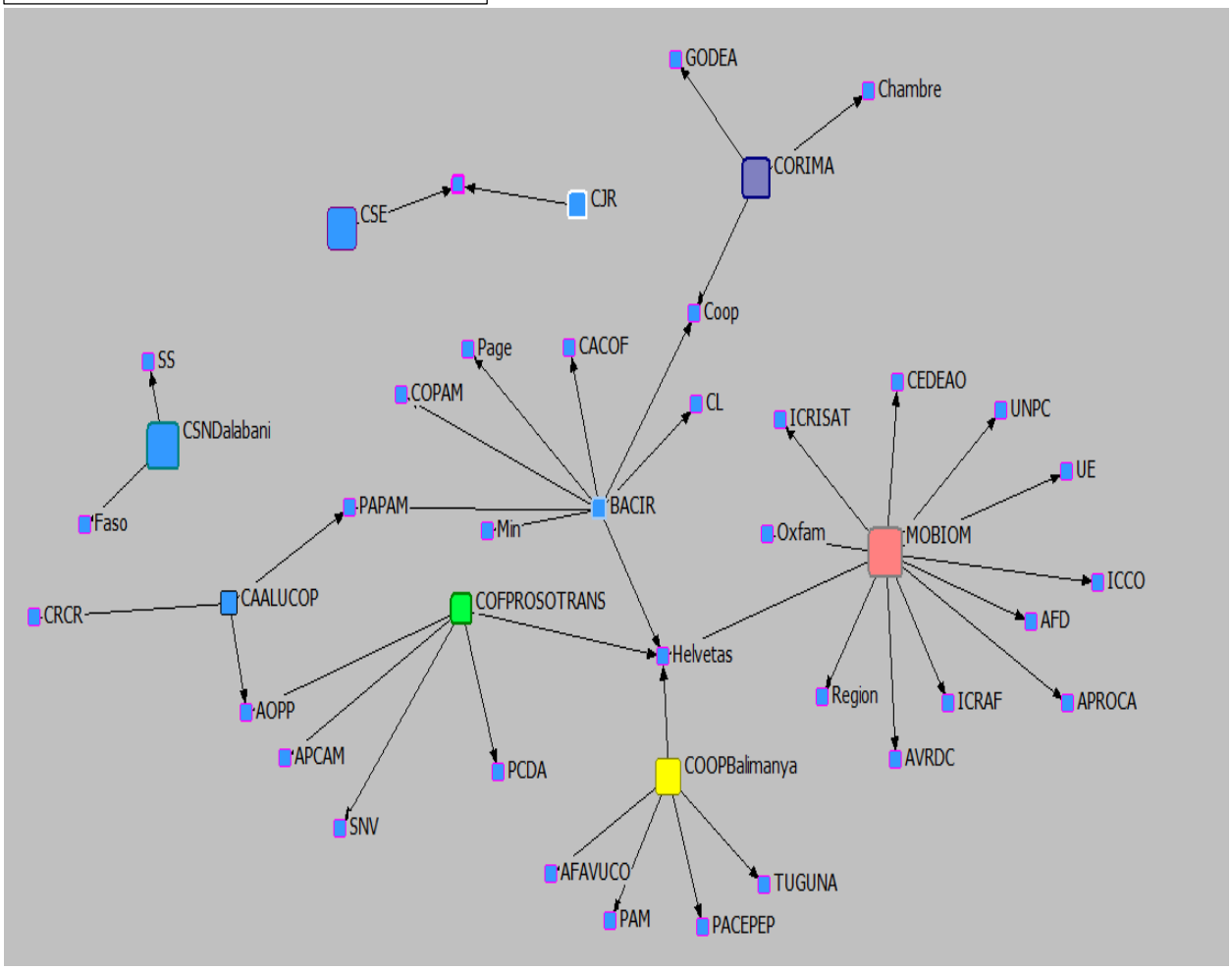


This involved individuals from the represented organizations answering a set of question posed in a questionnaire. These questions were used to map the existing linkages and analyze the strength of the same using social network analysis theories and to make an assessment of different micro-scenarios that represent different elements of the interactions and innovation capacity such as the strength of partnership, knowledge sharing, coordination of activities to triangulate information, frequency of interaction, strength of interaction.

Social network analysis (SNA) is a set of theories, tools, and processes for understanding the relationships and structures of a network.

The “nodes” of a network in this study are the stakeholders and the “links” are the relationships between people. The maps in this document were created using NETDRAW.

Figure 6: Collaboration network in Bougouni



Figures 5 and 6 display the patterns of the connections between nodes in Koutiala and Bougouni. A number of lessons can be drawn from these figures:

- In Koutiala, one can identify the appearance of five clusters[1] featured by: (1) AMEDD (Agence Malienne pour l'Environnement et le Development Durable), (2) AMASSA (Association Malienne pour la Securite et la Souverainete Alimentaire), (3) UCPTC (Union des Cooperatives des Producteurs et Transformateurs de Cereales), (4) CCPAM (Centre Commercial des Produits Agricoles du Mali), and, (5) ULCFBV (Union locale de cooperative de la filiere betail et viande).
- Four clusters in Bougouni feature by: (1) MOBIOM (Mouvement Biologique Malien), (2) BACIR (Bureau d'Appui-Conseils aux Initiatives Rurales), (3) COFPROSOTRANS (Cooperative feminine pour la promotion du soja et la transformation des produits agroalimentaires), and, (4) COOP Balimanya (Cooperative Balimanya).
- Some stakeholders can be considered as "bridgers" or "brokers" i.e. stakeholders in the network who have connections to different clusters. AMEDD seems to plays that role in Koutiala while Helvetas does the same in Bougouni. Indeed, bridgers provide valuable opportunities for innovation, growth, and impact because they have access to perspectives, ideas, and networks that are otherwise unknown to most network members. Finding bridgers in a network is typically done with the calculation called betweenness centrality (Scott, 2000). This calculation indicates how often one actor is likely to be an important relay point between other network members.
- The maps also show the existence of hubs defined as stakeholders in a network with the most influence. Hubs of influence in a network are best measured using directed links. Given a network of directed relationships, indegree centrality counts how many relationships point towards an actor: this provides a simple measure of influence (Freeman, 1979). In Koutiala, ICRISAT appears to be the most influential stakeholder and Helvetas in Bougouni as they are highly sought-after by other network members.
- In most cases, the interactions among actors in the two sites seem to be guided by a one-way directed links jeopardizing in practice the connectivity of such networks.

[1] According to Hoppe and Reinelt (2010), a cluster is a tightly knit, highly bonded subgroup. Identifying clusters is one of the most important applications of SNA, because it illuminates important previously unrecognized subgroups. Roughly speaking, a cluster is a local region in a network with relatively high density and relatively few links to other clusters.

Improved fruit tree plantation

Eight accessions grafted on three indigenous fruit tree species (*Adansonia digitata*, *Tamarindus indidica and Ziziphus mauritiana*) were planted in 2013 in order to determine the effect of irrigation on the growth, the phenology and fruit production on grafted plants.

The accessions were composed of 3 cultivars of *Ziziphus mauritiana* (Gola, 3A, ICRAF08), 3 superior genotypes of *Tamarindus indica* (Niger-309, Thailand sucré, Thailand Gros fruit), 1 genotype of *Adansonia digitata* (Nonokene) and 1 genotype of *Vitellaria paradoxa* (Samanko-ka).

The trial was established in a randomised block design with 3 replications. Mpessoba, Sirakele and Zanzoni are the villages that the 3 replications. The experimental unit was composed of 6 plants. The plants were monitored while dead plants were replaced in August 2014. When the root stocks were alive, grafting was done in situ in order to increase their survival rate. The survival rate ranged from 75 to 100 % (Figure 1). *Ziziphus mauritiana* was the most sensitive with higher scion and plant mortality compared to *Adansonia digitata* and *Tamarindus indica*. Regarding growth parameter (height, collar diameter, and canopy) the results are summarized in table 1. There are significant differences among accessions for all the 3 parameters evaluated. Jujub Gola had the highest height while *Vitellaria paradoxa* plants had the lowest height relative growth rate.

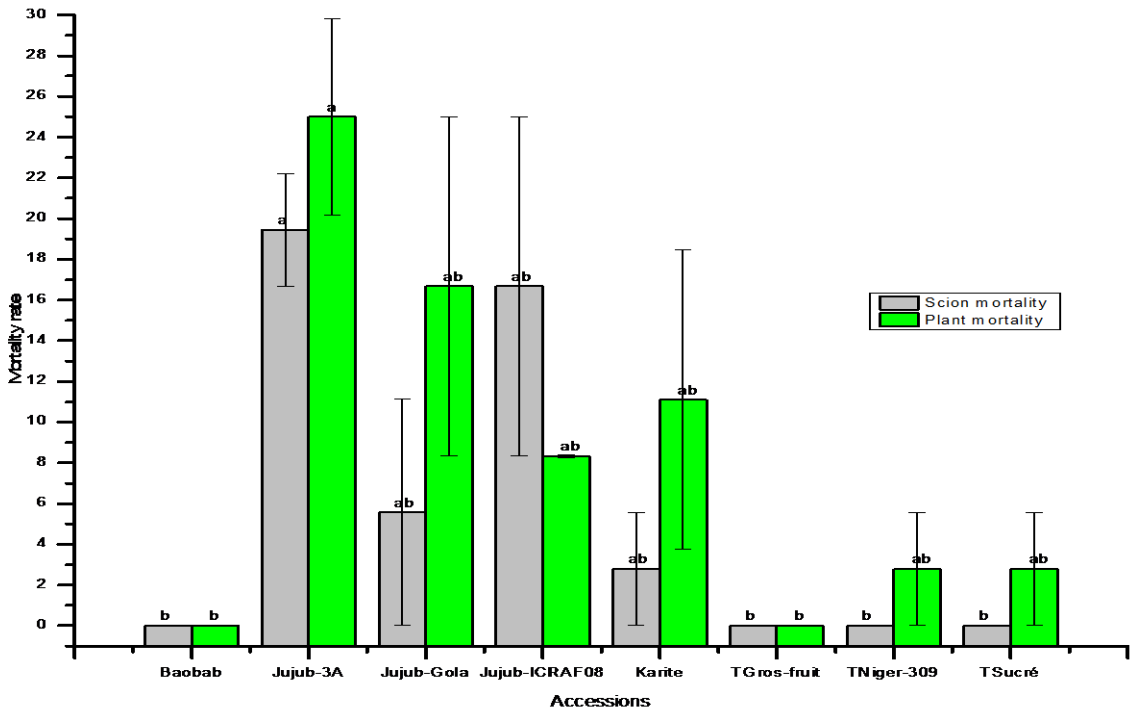


Figure 1. Mortality rate of scion and entire plants of 8 accessions grafted on seedlings of *Adansonia digitata* (Baobab), *Tamrindus indica* (Jujub) and *Tamarindus indica* (T) planted in 2013 in Mpessoba, Sibirila and Zanzoni. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Table 1. Growth parameters monitored on 8 accessions planted in 2013 in Koutiala and Bougouni cerles in Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Accession	Height (cm)	Diameter (mm)	Canopy width (cm)
Baobab non-kene	66.6±8.4b	26.4±4.4a	42.1±8.7bc
Jujub-3A	97.7±13.2ab	13.4±1.9abc	72.3±10.1a
Jujub-Gola	133.2±15.5a	13.4±2.2bc	90.9±13.6a
Jujub-ICRAF08	98.6±12.9ab	12.0±1.6bc	53.2±8.2abc
Vitellaria Samanko-ka	11.18±1.5c	10.9±0.8bc	24.8±2.6c
Tamarin Gros-fruit	89.5±8.2ab	19.6±1.9ab	73.8±7.9a
Tamarin Niger-309	66.9±8.5b	10.9±1.0c	54.7±5.7ab
Tamarin Sucré	79.3±7.6b	13.7±1.3abc	59.6±6.6a

Fruit tree species planted in 2014

In 2014, 3 other experiments were established to determine the effect of propagation mode (grafted, non-grafted plants) and irrigation on 2 indigenous fruit tree species *Vitellaria paradoxa* (Samanko-ka) and *Adansonia digitata* (Nonokene), to compare 5 improved cultivars to non-grafted seedlings of *Ziziphus mauritiana* and 3 superior accessions compare to non-grafted *Tamarindus indica*. Grafted and non-grafted plants of *Vitellaria paradoxa* and *Adansonia digitata* were established in a randomized block design with 7 replications (Nampossela, Ngolonianasso, Medina-Kourlamini, Djeba, Flola, Sibirila and Yorobougoula) as other experiments. The experimental unit was composed of 5 plants.

As the factor irrigation has not yet started, propagation mode (grafted, non-grafted), and their interaction along with the villages considered as replications were the factors stated in the statistical analysis. The results of the first evaluation after plantation are given in tables 2, 3 and 4.

Table 2. Main effects of species on growth parameters of grafted and non-grafted plants of *Adansonia digitata* and *Vitellaria paradoxa* planted in Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Species	Height (cm)	Diameter (mm)	Canopy width (cm)
Adansonia digitata	45.1±1.3a	11.8±0.6a	11.6±1a
Vitellaria paradoxa	13.2±0.7b	5.5±0.4b	15.6±1.1a

Table 3. Growth parameters monitored on 4 accessions of *Tamarindus indica* planted in 2014, Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Accession	Height (cm)	Diameter (mm)	Canopy width (cm)
Gros-fruit	22.2±1.2b	5.3±0.4a	13.7±0.9b
Niger-309	22±1.3b	4.7±0.3a	13.7±1b
non-greffé	27.7±1.4a	5.1±0.2a	19.5±1a
Sucré	25±1.9ab	5.5±0.4a	16±1b

Table 4. Growth parameters monitored on improved 5 accessions and non-grafted seedlings of *Ziziphus mauritiana* planted in 2014, Mali. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Accession	Height (cm)	Diameter (mm)	Canopy width (cm)
Jubjub 3A	31.1±2.4ab	4.8±0.4ab	15.3±1.5b
Jujub Ben-Gurion	32.9±2.6ab	5±0.3ab	22.1±2.1ab
Jujub Gola	35.7±2.4a	4.4±0.2ab	21.5±1.7a
Jujub ICRAF08	28.1±2.1ab	4.8±0.4ab	19.7±2.1ab
Jujub Umran	33±2.6ab	5.2±0.4a	18.4±1.7ab
Jujub non-greffé	27.3±1.9b	3.9±0.4b	18.2±1.7ab

Food banks

Three spacing types (0.3m x 0.3m, 0.5m x 0.5m and 1m x 1m) were used to install 11.25 m^2 plots (4.5m x 2.5m) for leafy vegetable production of *Adansonia digitata* and *Moringa oleifera* in 9 villages out of 10 villages selected for Africa RISING project. Vegetable is being collected every month for selling or consumption.

Table 5. Main effects of species on growth parameters of garden plot planted seedlings of *Adansonia digitata* and *Moringa oleifera* planted in Mali in 2014. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test.

Species	Height (cm)	Diameter (mm)	Canopy width (cm)
Baobab	13.8±1b	4.5±0.3b	11.5±0.4b
Moringa	101.2±6.9a	14.9±0.9a	51.7±2.2a

Table 6. Main effects of spacing on growth parameters of garden plot planted seedlings of *Adansonia digitata* and *Moringa oleifera* planted in Mali in 2014. Mean ± SE followed by the same letter are not significantly different at the 5% level according to Tukey's multiple comparison test

Spacing	Height (cm)	Diameter (mm)	Canopy width (cm)
30 cm	70.9±8.2A	10±1a	32.8±3.2a
50 cm	69.1±8.7A	10.9±1.1a	34.9±3.1a
100 cm	57.4±10B	11.5±1.3a	39.6±3.7a

In collaboration with the local NGO AMEDD two fields of 7 ha in Mpessoba, and 6 ha in Sibirila were managed for water and soil conservation trial. AMEDD technician had laid out four contour lines in each of the fields and also trained farmers for contour line plowing. On the downstream of the contour lines, seedlings of 6 fertilizer and fodder species (*Acacia angustifolia, Acacia colei, Calliandra callotyrsus, Gliricidia sepium, Moringa oleifera,* and *Piliostigma reticulatum)* were established. The first evaluation revealed high mortality of *M. oleifera, A. angustifolia,* and *C. callotyrsus*. A. colei and P. reticulatum had the highest survival rates.


CGIAR


FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative


USAID
FROM THE AMERICAN PEOPLE