INNOVATIONS IN SEED SYSTEMS:

LESSONS FROM THE CCRP-FUNDED PROJECT "SUSTAINING FARMER-MANAGED SEED INITIATIVES IN MALI, NIGER AND BURKINA FASO"

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF BOXES

SUMMARY

This case study is part of a series of case studies commissioned by the McKnight Foundation, Minneapolis/USA based on the work of its Collaborative Research Program (CCRP). The aim is to assess the efficiency and effectiveness of the CCRP approach as evidenced by the accomplishments and contributions of selected CCRP-funded projects. The study on seed systems presented here takes place in this context and is based on the CCRP-funded project, *"Sustaining Farmer-Managed Seed Initiatives for Sorghum and Pearl Millet in Mali, Niger, and Burkina Faso"*. This project aims to contribute to sustainable seed supply to smallholder farmers in three West African countries through farmer-managed production of seed.

The objectives of the case study can be summarized under four aspects: (1) describing the project background and context; (2) describing the project outcomes; (3) assess specific CCRP contributions; and (4) summarize lessons learnt and recommendations.

In order to achieve this, we applied a qualitative approach based on semi-structured interviews and focus group discussions, combined with formal questionnaires. Besides ICRISAT, the partner organizations included the national research organizations in Mali (IER), Burkina Faso (INERA) and Niger (INRAN), as well as two farmer organizations each in Mali and Burkina Faso, and three in Niger. Altogether, 45 interviews were conducted with scientists (n=10), technical staff (n=11), representatives of farmer organizations involved in the project activities (n=13), farmer seed producers (n=118), and other key informants representing for example chambers of agriculture, national farmer organizations, private seed enterprises and seed authorities (n=13). Out of the farmer seed producers, 31 were women (36%) and 87 men (64%).

The evaluation criteria were borrowed from two theoretical frameworks: The Seed System Security Assessment (SSSA), and the criteria for assessing development impact used by the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD).

The SSSA framework describes three basic functions of seed systems: Availability of seed, access to seed and quality. Availability refers to the production side of a seed system, whereas access focuses on the demand side. Quality refers to seed utilization, for example how useful the varieties offered are for a particular context of for different user groups. It further implies technical quality of the seed offered.

The OECD DAC criteria include (1) relevance, (2) effectiveness, (3) efficiency, (4) impact and (5) sustainability, and are meant to evaluate the broader development impacts and the use of funds and resources. Moreover, gender and equity issues were addressed in our methodology.

The first part of the results is a description of the project context as well as of the state of scientific knowledge on innovations in seed systems and the political dimension involved. We outline the importance of the sorghum and pearl millet crops for the farming and food systems of the project area, and the main constraints. Advances through research have remained limited so far, also because variety adoption has occurred at a relatively low level and because formal seed systems for making improved varieties available to farmers did practically not exist for staple food crops, such as sorghum and pearl millet. The project studied has followed an alternative approach by tying participatory variety development and evaluation to farmer-managed seed production, and by involving farmer organizations as project partners.

This project was found to be highly relevant as it suggests solutions to prevailing problems of agricultural food and farming systems in the West African region, including stagnating agricultural yields, climate variability and change, scarcity of resources, population growth and malnutrition. All organizations involved in the project relate their activities to these same challenges.

The project has successfully contributed to improving seed system security in the area by targeting all three aspects. The core of the success is the development of varieties that are adapted to the context and produce

considerably higher yields under farmers' production conditions, while also maintaining a number of other preferred traits. Through the decentralized, participatory variety evaluation trials, farmer shave gained contextualized knowledge on these varieties and can take informed decisions on the options available to them. The availability of seed of these varieties has much improved. The number of seed producers has increased from year to year over the years, as has the area used for seed production. Area-wise, the total amount of seed produced by the farmer organizations in 2013 was estimated to be sufficient for sowing 16000 ha of sorghum and 11500 ha of pearl millet. By taking a 'mini-packet' approach for seed marketing to individual farmers, access to seed has also improved. Besides, there are several other pathways for seed distribution, including with government agencies, NGOs or private seed enterprises acting as partners of the farmer organizations.

The project activities have proven to be effective with regard to the goals set, and compared to other previous activities targeting seed sector development in the region, they appear to be highly efficient. Impacts reported by farmers included four different domains: (1) Impact relating to variety adoption and seed systems (2) Impact relating to productivity, income and nutrition (3) impact relating to knowledge, innovation and development capacities, and (4) potential negative impacts.

We can thus summarize that the project has convincingly demonstrated that farmer-managed seed production is feasible, and can in this particular case improve variety adoption and achieve development impacts. The goals set were achieved to a quite high degree. However, there are challenges ahead with regard to the sustainability of the project. Besides some necessary improvements in the seed chain itself, our concerns are about reducing risks for the farmer organizations and improving the material resource basis for the farmer organizations and the national research institutes. Moreover, the sustainability of this project depends to a very high degree on external factors, including decisions that are taken at the policy level. These external factors should be addressed, which may imply research and capacity building measures which go beyond the original focus of the project.

Our main recommendation is that funding and support to the project should not be withdrawn at the present stage in order to secure the positive impacts achieved so far. The project is presently at an important turning point, from a mere experimental 'research' stage, in which methodologies were tested and capacities built, towards broader implementation. The project should support this transition by addressing remaining challenges in the seed chain itself, and by developing a broader strategy for seed sector development.

In the seed chain, those linkages where farmer organizations directly depend on other actors should be improved. We identified three critical junctions: (1) provisioning of source seed, (2) seed certification and (3) coordination of complementary dissemination pathways. We further emphasize that not only knowledge and capacity building, but also a material resource base and risk-reducing measures may be necessary to make the farmer-managed seed production more sustainable. In order to address the seed sector as a whole, we suggest conducting a policy and a stakeholder analysis in order to indentify entry points for a science-policy dialog, and to establish multi-stakeholder platforms in order to facilitate the development of shared visions and coordinated action towards the integrated development of more sustainable, equitable and resilient seed systems in the three countries.

1 INTRODUCTION AND BACKGROUND

The McKnight Foundation (MF) is commissioning a series of case studies based on the work of its Collaborative Research Program (CCRP). The aim is to assess the efficiency and effectiveness of the CCRP approach as evidenced by the accomplishments and contributions of selected CCRP-funded projects.

By doing so, MF seeks to review the impact of the applied research funded under the CCRP program and the extent to which it has facilitated development, spread of technology, food security and the improvement of farmers' livelihood. A focus is on how CCRP's financial and non-financial support has benefitted the projects' and organizations' research and development capacity over time, particularly the R&D sustained capacity among local institutions and approaches. Furthermore, the case studies should result in recommendations for future sustainability, farmer involvement and skill strengthening.

The study on seed systems presented here takes place in this context and is based on the CCRP-funded project, *"Sustaining Farmer-Managed Seed Initiatives for Sorghum and Pearl Millet in Mali, Niger, and Burkina Faso"*. This project aims to contribute to sustainable seed supply to smallholder farmers through farmer-managed production of seed. A major focus is on strengthening the capacity of farmer groups for quality seed production, monitoring of seed quality, book keeping, seed marketing and prediction of demand, data documentation, and communication of results. Women were to be explicitly involved in the project's key activities. The project also made specific efforts at developing a better understanding of the impacts achieved, especially in terms of dynamics in seed networks and farmers' access to seed.

In the process leading to commissioning this particular case study, Robert Tripp summarized the results of a brief consultancy to narrow down and substantiate the focus of a case study on the topic 'seed' (Tripp, 2013). He emphasized the fact that the term 'seed' does not refer only to a physical commodity, and that an exceptionally large number of activities can be applied to it, including activities related to plant breeding, to extension and training, analytical activities (e.g. analysis of seed systems), to seed production activities, relevant policies and technical outcomes, such as variety adoption. He stated that it will be useful to focus a case study on a sub-set of seed-related activities, rather than to attempt to simultaneously address the many possible areas that can be considered 'seed-related'. Moreover, a case study on seed systems should focus more on organizational or institutional progress, opposed to the mere production and/or utilization of a commodity, and thus on the change in capacities for providing (adequate) seed in a sustainable manner, among companies, farmer organizations and government entities.

In our case study, we take up these recommendations by focusing on developments in the seed system, particularly on improvements concerning *availability* of seed, farmers' *access* to seed and seed *quality*. We thus exclude the breeding part or the spread of particular varieties. However, the availability of varieties that are attractive to farmers is an important prerequisite for seed system development, and the diversity and relevance of the varieties on offer touch the quality aspect of a seed system. We thus tend to regard the breeding and seed system as one, but focus our study on activities relating to seed production, marketing and distribution.

Moreover, we look into development impacts of the project and the specific contributions of the CCRP, particularly the capacity building and networking activities that formed part of the project. To some minor extent we consider the broader political context in which the project has been implemented, to explore its relevance and coherence with national policies, and the external supporting or hindering factors.

We started preparing the case study from November 2013 with establishing first contacts and meetings, leading to the creation of a team, formal contracts and an agreed-upon methodology. This led us to three major activities: (1) Collecting written documents for review with the help of project partners, (2) communication via formal questionnaires and e-mail for basic and quantitative information, and (3) an evaluation mission conducted in February 2014. Furthermore, some background interviews and meetings, either personal or via 'skype', complemented the information and helped to focus the study.

Between February 1 and 16, the evaluation team, consisting of Gottfried Horneber and Marthe Diarra visited scientists, farmer organizations, representatives of government entities, private enterprises and NGOs in all three countries where project activities were implemented: Mali, Burkina Faso and Niger. By meeting project partners in all three countries, we took up the idea of a regional 'Community of practice' relating to seed and variety development in West Africa. This decision, however, resulted in less time being spent with each project partner, and also less possibility to explore the surrounding context of each individual initiative.

2 OBJECTIVES

The MF's interest is focused on the impact relating to the more technical outcomes of the applied research, as well as on its broader development impact. Moreover, the case study aims at understanding how the funding and support given under the CCRP program has specifically contributed to capacity building among the institutions involved, and which lessons can be learnt for the future strategic orientation of the program.

The objectives of this case study can thus be summarized under four main aspects:

(1) Project background and context: Issues surrounding the project and the regional context the project has been operating in, including the issues relating to seed systems and the pearl millet and sorghum crops.
(2) Outcomes: The set-up and strategy of the project, its accomplishments, major landmarks and re-orientations in relation to the goals pursued, and the capacity building of organizations and institutions involved.
(3) CCRP contributions: Perception of grantees relating to key elements of the CCRP approach, relation to other projects and funding, impact on research and development capacity and adaptive learning capacity of institutions involved.
(4) Lessons learnt and recommendations: Lessons from the project's experiences and areas for improvement in CCRP support, including implications for the future CCRP strategy for strengthening smallholder-focused seed systems in West Africa.

3 METHODS

In this section, we provide information on the theoretical frameworks on which we based our assessment, the methodologies for selecting sites and interview partners, for obtaining and structuring information in the field and via questionnaires, and for evaluating the results.

3.1 THEORETICAL FRAMEWORKS FOR THE ASSESSMENT

In accordance with the above stated objectives, we based our assessment on two widely accepted and applied theoretical frameworks: the Seed System Security Assessment (SSSA) and the criteria used by the Organisation for Economic Co-operation and Development (OECD) for assessing development impact. By combining these two approaches in our methodology, we took account of the MF's stated interest to assess both, the impact relating to improvements in seed systems and the development impact. Moreover, several cross-cutting issues were addressed, e.g. gender and equity considerations.

SEED SYSTEM SECURITY ASSESSMENT (SSSA)

SSSA has been developed and used by several groups of researchers and development practitioners since the 1990ies. Its original focus was on better targeting seed aid interventions in the context of disaster relief (Remington et al., 2002; Sperling, 2008). The basic idea of SSSA is to understand how seed systems function in normal situations, and to assess their strengths and weaknesses. Based on this assessment, any interventions in crisis or disaster situations can be designed in a way that they build on the strengths and compensate for

weaknesses. The SSSA concept is strongly related to food security frameworks commonly used by aid organizations (e.g. LIFT, 2011). Therefore, it 'fits' into strategies that aim at improving food and livelihood security.

SSSA has caught interest from other researchers working on seed systems, because knowing the strengths and weaknesses of a seed system can also help to identify strategic entry points for other interventions into seed systems, not only in disaster situations. For example, it can be a question how existing seed systems can be strengthened and developed further, and how new institutions can be build up, in situations where traditional seed systems have become weak.

According to the SSSA concept, seed system security is looked at under three general aspects:

- Availability of seed
- Access to seed
- Quality of seed

Availability of seed describes the *production* part: whether seed is being produced, stored and sold in adequate quantity and at the right time. Access to seed draws attention to the *demand* side: Do (all) people have the means to buy or barter for seed, and is the seed sold/distributed in a way that (all) people can access it, physically and economically? Quality of seed finally emphasizes the *utilization* aspect: whether and to which extend the seed meets people's multiple needs and requirements. Thus, quality here entails more than just technical seed quality (e.g. germination capacity, seed health, purity). It further includes varietal properties – whether varieties are adapted to the existing farming systems and agro-ecological conditions, meet the requirements of market partners or fulfill consumer needs, such as processing quality and nutritional value. Moreover, the functional diversity of varieties on offer could be regarded as part of a seed system's quality.

In our case study, we did not actually do a SSSA, but we used the concept and the underlying criteria to structure and ask for information. Looking at seed systems under these aspects can help assess whether and how innovations applied have contributed to overcoming existing weaknesses of the seed systems that were identified in the baseline studies or diagnostic studies.

OECD CRITERIA FOR EVALUATING DEVELOPMENT ASSISTANCE

The OECD is a forum where the governments of 34 states work together to address the economic, social and environmental challenges of globalization. In order to achieve its aims the OECD has a number of specialized committees, one of which is the Development Assistance Committee (DAC). DAC members periodically review the nature of their contributions to aid programs, and consult each other on relevant aspects of their development assistance policies (OECD, 2013a). The OECD DAC has developed principles and quality standards for the evaluation of development assistance since the 1990ies; periodic reviews look at how evaluation systems are evolving and examine current issues (OECD, 1991; OECD 1998; OECD 2000).

The OECD DAC suggests considering the following criteria for evaluation development assistance (OECD, 2013b):

- *Relevance*: The extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor.
- *Effectiveness*: The extent to which an aid activity attains its objectives.
- *Efficiency*: measures the outputs - qualitative and quantitative - in relation to the inputs. It is an economic term which signifies that the aid uses the least costly resources possible in order to achieve the desired results. This generally requires comparing alternative approaches to achieving the same outputs, to see whether the most efficient process has been adopted.

- *Impact*: The positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended. This involves the main impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators.
- *Sustainability* is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally, socially as well as economically sustainable.

The OECD DAC criteria thus represent a framework for the evaluation of the broader development impact of projects, besides their technical outcomes. As stated above for the SSSA, we used the OECD DAC criteria for structuring our evaluation and focusing our questions towards them.

ADDITIONAL CRITERIA

In addition to the above criteria, we considered gender and equity issues in our methodology. 'Gender' is being referred to here in the broader context of intersectionality, which means that we have in general to be aware that project activities or outcomes can benefit or affect people differently, e.g. depending on age, gender or ethnic groups they belong to.

Involving women and men in key project activities was a goal set by the project itself, but apart from this it is a widely accepted quality criterion for project evaluations. Moreover, gender is a sensitive issue for activities relating to seed.

We addressed gender aspects in our team composition, with Gottfried Horneber and Marthe Diarra forming the evaluation team, thus representing both genders in the team and both having specific expertise and experience with regard to the topic. No separate groups were formed for women and men during the fieldwork, but care was taken to allow the participating women, who were in most cases outnumbered by male participants, to express their views. In one case a special interview was organized with members of a women seed producer group. Gender-specific aspects of seed system development were part of the joint reflections in our team and are presented in the results section where found relevant.

3.2 SELECTION OF SITES AND INTERVIEW PARTNERS

The selection of sites visited depended on where the project partner organizations were based and/or enrolled their field activities. The project partner organizations included ICRISAT and the National Agricultural Research Institutes (NARI), farmer organizations and seed producer groups. Moreover, some additional key informants, e.g. representatives of Ministries of Agriculture, Chambers of Agriculture, National Seed Services, commercial seed enterprises and NGOs were contacted and/or visited.

Project partners and their representatives in Mali, Burkina Faso and Niger were identified with the help of contact persons denominated by ICRISAT and the McKnight Foundation. Furthermore, a contact list was circulated via e-mail in order to give more people the possibility to add key informants and organizations. For the selection of participants the evaluation team depended on the technical staff of farmer organizations ICRISAT as they had invited to the meetings. The farmer participants were (1) representatives of the farmer organizations, and (2) members directly involved in project activities, e.g. farmer seed producers. We did not organize an inquiry among all members of these farmer organizations, or a representative sample of all villagers, as our focus was on people who actively participated in project activities.

The evaluation team spent 4-5 days in each country. Besides the research organizations, two farmer organizations per country were visited in Mali and Burkina Faso, including visits to seed producer groups and facilities for seed storage, processing and selling. In Niger, only one farmer organization and field location was visited and in addition a meeting with representatives of two other farmer organizations was conducted at Niamey due to security and time considerations. Altogether, the evaluation team conducted 45 interviews. Interview

partners were scientists (n=10), technical staff (n=11), representatives of farmer organizations involved in the project activities (n=13), farmer seed producers (n=118), and other key informants representing for example chambers of agriculture, national farmer organizations, private seed enterprises and seed authorities (n=13). Out of the farmer seed producers, 31 were women (36%) and 87 men (64%).

Women are generally underrepresented in leading positions of institutions in West Africa, as in many other parts of the world. Where interview partners were selected based on their official assignment (e.g. researcher responsible for sorghum breeding, or president of a farmer organization), only few women were among the interview partners. Women are also underrepresented in the seed producing activities. Tables 1a and 1b list the research and farmer organizations that contributed to the evaluation. Detailed information regarding individuals and organizations visited is given in Annex A.

Even though covering a range of agro-ecological conditions was not our focus in selecting sites and interview partners, the farmer organizations work in different regions and accordingly focus on producing either sorghum or pearl millet seed. Therefore, the main crop and average annual rainfall data of the location were included in Table 1b (see next page).

Our original intention to include some potentially critical perspectives of people and organizations acting in the field, but who are not involved as project partners, was not very fruitful. E-mail inquiries (e.g. directed to several 'La via campesina' member organizations in Mali, Niger and Burkina Faso) were not answered, and some representatives of organizations visited did not seem to be well enough informed about the project to provide detailed feedback.

3.3 FIELD METHODS

For the fieldwork, the evaluation team relied on semi-structured interviews. Interview guides had been prepared beforehand, separately for scientific and local partners, in order to make sure that all important topics were covered in the discussions. Evaluation questions were formulated as open questions, for example how participants had benefitted from project activities and trainings, or what gains and losses were achieved.

We further used the 'Most Significant Change' (MSC) technique, which is a Participatory Monitoring and Evaluation (PM&E) tool that does not rely on pre-defined indicators. It is most useful in cases where the outcomes of a project vary widely between stakeholders, or where there has not yet been an agreement among them on what outcomes or impacts are 'important'.

Essentially, the process involves the collection of individual participant's 'stories' on impacts they experienced, followed by a joint reflection in the group, and/or at higher organizational levels. Rick Davies, who first described and applied the method, called it an *"evolutionary approach to facilitating organizational learning"* (Davies, 1996). MSC can thus be used to create hypotheses about changes that took place, and also to identify and understand the underlying criteria, values and rationales. It is further useful to capture unexpected or negative change (Davies & Dart, 2005).

We had originally planned to use supportive visual tools, but this turned out to be difficult because a large number of quite focused questions and topics were to be addressed, rather than initiating an open dialog. That is why these tools were finally not implemented.

Table 1a: Research organizations contributing to the evaluation in Mali, Burkina Faso and Niger

Country	Location	Scale of activities	Name of organization
Mali	Bamako	International	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Mali	Bamako	National	Institut d'Economie Rurale du Mali (IER),
Burkina Faso	Ouagadougou	National	Institut de l'Environnement et de Recherche Agri-cole (INERA)
Niger	Niamey	International	International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Niger	Niamey	National	Institut National de Recherche Agronomique du Niger (INRAN)

Table 1b: Farmer organizations contributing to the evaluation in Mali, Burkina Faso and Niger

Country	Location (region)	∅ Annual rainfall [mm]	Focus crop	Name of organization
Mali	Mandé/Siby (Koulikoro)	750-1000	Sorghum	Association des Organisations Profes-sionnelles Paysannes/ Coopérative des Producteurs Semenciers du Mandé (AOPP/COOPROSEM)
Mali	Dioïla (Koulikoro)	750-1000	Sorghum	Union Locale de Producteurs Céréales (ULPC)
Burkina Faso	Kaya (Sanmatenga)	500-650	Sorghum	Association Minim Sông Pânga (AMSP)
Burkina Faso	Dédougou (Boucle du Mouhoun)	800-950	Sorghum	Union Groupements Commercialisation des Produits Agricoles de la Boucle du Mouhoun (UGCPA/BM)
Niger	Falwel (Dosso)	385-490	Pearl millet	Union des producteurs 'MADDA-BEN' /Fédération des Union de Groupements Paysans du Niger Mooriben (MADDA-BEN/FUGPN Mooriben)
Niger	Téra (Tillabéri)	310	Pearl millet	Union de groupements paysans 'HA-REYBEN' Téra/ Fédération des Union de Groupements Paysans du Niger Moori-ben (HAREYBEN/FUGPN Mooriben)
Niger	Serkinhoussa (Maradi)	410	Pearl millet	Fédération des Unions de Producteurs de Maradi (FUMA- Gaskiya)

Sources: CCRP project report "Farmer-participatory improvement of sorghum and pearl millet genetic resources for increased adaptation to diverse production environments in West Africa, Report March 2008 – February 2009 & questionnaires.

3.4 QUESTIONNAIRES

Different questionnaires were developed for local organizations and scientific partners and sent out shortly before the field visits took place. They helped reduce the number of topics to be explored during the visits, and included some quantitative information e.g. on the development of seed production and sales.

The questionnaires were handled independently and by another person, so that we consider this as a form of triangulation to complement the information from the field. They also opened up the possibility to start an e-mail correspondence and ask for documents or clarifications.

We expected that the flow of information via this channel would be limited. We received filled-in questionnaires from all farmer organizations, but only few from researchers.

3.5 EVALUATION OF RESULTS

The findings of the field study were documented by taking notes and discussing the results and preliminary findings in the evaluation team. The questionnaires were designed in a way that the questions related directly to the SSSA framework and the OECD DAC criteria, so that the information could be summarized under these topics. For 'skype' interviews, notes were taken in a structured form using the OECD DAC criteria as headings, and complemented with further pre-defined questions, for example relating to breeding techniques or the legislative framework. Quantitative information, such as the number of producers, varieties and amount of seed produced, were evaluated graphically to identify trends.

The findings were then assembled in the results section under five topics: project context, project design, seed system development, development impact, and CCRP contributions. In order to draw lessons and recommendations from the findings in view of future programs and projects, we summarized strengths, weaknesses, opportunities and threats in a SWOT matrix.

In order to build trust, we had assured our interview partners that the information and particularly personal statements, opinions and recommendations would be treated confidentially. That is why information appears in this report in an aggregated form or without presenting the names of informants.

A draft version of the report was shared with the MF and Dr. Eva Weltzien to get feedback before preparing a revised, final version.

4 RESULTS

As mentioned above, we will summarize the results of our study under five broad sections: (4.1) the general context and background of the project, (4.2) the project design, (4.3) the project outcomes with regard to seed system development, (4.4) the development impact of the project, and (4.5) the specific contributions of the MF's CCRP Program.

4.1 PROJECT CONTEXT

In this section, we will summarize shortly how informal and formal seed system development emerged on the agenda of agricultural scientists and development practitioners since the 1990ies, also in connection with plant breeding projects. Furthermore, we will highlight that seed system development is not only a question of technical and institutional development, but also a highly political issue that forms part of a more general controversy on the future orientation of agriculture. In a third subsection, we will introduce the concept of 'Integrated Seed System Development' that aims at balancing multiple functions and goals seed systems have to fulfill. Finally we shortly describe sorghum and pearl millet production and seed systems in West Africa.

INFORMAL AND FORMAL SEED SYSTEMS

Since the 1990ies, the functioning and development of traditional seed systems has emerged on the agenda of agricultural scientists and development practitioners alike. Initial studies highlighted the general importance of traditional (informal) seed systems for sustainable seed supply of the vast majority of the world's food crops. It was estimated that informal sources of seed supply, including farm-saved seed, seed from neighbors and relatives, or from local markets and traders, accounted for 80-90 % of the total seed supply worldwide (Almekinders et al., 1994). A recent assessment including data from six African countries showed that farmers even today obtained as much as 90% of the seed they used from informal sources (Sperling & McGuire, 2013). These findings underline the quantitative importance of informal seed systems for food and farming systems worldwide.

Some of the basic insights into the functioning and structure of these traditional, informal seed systems stem from people working in emergency aid, concerned about the effectiveness of seed aid and its effects on seed system security in the longer term (Remington et al., 2002; Sperling and Cooper, 2003). It was found that very similar to the situation concerning food, seed of local varieties is nearly always available with some farmers even in disaster situations, but other farmers may lack access to it due to deficient purchasing power or social marginalization. These findings put focus on the ways how seed is being managed and disseminated in local, informal systems, and the related strengths and weaknesses, including equity issues.

Such issues were also addressed in some basic research on social and anthropological aspects of traditional seed systems: Distribution pathways, management, terms and conditions of exchange, and the way how seed systems are embedded in social systems (Longley, 2002; Badstue et al., 2002; Badstue 2007; Christinck, 2002; Delêtre et al., 2011). Some of these studies further focus on the relation between traditional seed transactions and genetic diversity of crops (Christinck, 2002; vom Brocke et al., 2003; Delêtre et al., 2011; see also Jarvis et al., 2004).

Important findings that can be summarized from these studies are that most seed transactions in traditional seed systems, depending on the social relationship between the individuals involved, take the form of gifts or are based on non-monetary exchange. Most seed transactions take place in relative proximity, in other words within a village or clusters of neighboring villages. There are, however, opportunities for exchange over larger distances, mostly on the occasion of festivities, such as marriages, religious festivals, markets and fairs. Some individuals or groups may play a key role for seed exchange and diffusion in and among villages.

The importance of women in traditional seed systems has often been emphasized (see, for example, Tapia and de la Torre, 1998). In many countries, women play a key role in selecting, storing and distributing seed of important food crops. It is known that changes in seed systems tend to affect gender roles, re-distribute responsibilities for and access to resources, and may have effects on food and nutrition security (Howard, 2003; Pionetti, 2005; Momsen et al., 2013). Moreover, the informal seed system is particularly important for women farmers as a source of seed, given its advantages with regard to availability in the village neighborhood and access. In the informal seed system payments can be made flexibly, in cash or kind, or also based on other forms of reciprocity.

Other groups of researchers focused more on innovation and change in seed systems, particularly with regard to their capacity to provide access to newly developed varieties from breeding programs (Ndjeunga, 2002; Siart, 2008), or their adaptive capacity to new challenges, e.g. climate change (Bellon, 2011). Whereas the informal sector regularly provides seed of traditional varieties, diffusion of new varieties through informal channels is generally slow. Depending on flowering dates, outcrossing rate and varietal structure, challenges may arise for maintaining the varietal identity under on-farm conditions. This is even more the case for hybrid varieties. Without special measures being taken, and organizational structures being established, breeding progress achieved can be lost within few years. Therefore, it is a question how seed of newly bred varieties can be diffused efficiently to farmers in situations where formal seed markets are weakly developed.

Basic work on the conditions for the emergence of formal seed sectors in developing countries has been done by Tripp (2001; 2003; 2006). He argues for shifting seed production and dissemination of formal variety seed to the commercial sector, rather than investing in public seed enterprises, and also emphasizes on the complementary roles played by farmers and public institutions in the emergence of a commercial seed market.

According to Tripp (2003), a commercial seed market will develop only when it can offer farmers a clear advantage over seed saving on-farm. Such advantage could take several forms, including convenience, access to superior germplasm, and seed quality. Furthermore, demand can be stimulated if markets where farmers sell their produce pay premium prices for particular types of varieties. He states that "*on the one hand, farmers are often willing to pay a premium for seed of a new variety, but unless that seed is difficult to save, or there is a fairly constant offering of new varieties, it is not likely that a seed enterprise will be able to base its business solely on the provision of new varieties*." Other reasons for farmers to use seed from off-farm sources include poverty (no possibility to keep own seed) or quality problems, but both leading to occasional seed purchase rather than representing a stable source of demand. Moreover, farmers may more easily opt for buying seed from commercial sources if seed requirements are low, or if additional labor requirements for saving own seed is high, as is the case in some vegetable or forage crops (Tripp, 2003; Bentley et al., 2011).

Whereas traditional seed production is embedded in the normal routine of farming, with relatively few 'specialized' management decisions and working operations being particularly assigned to separating seed from the general harvest, this is different for commercial seed production, which entails a chain of highly specialized activities: Plant breeding and variety evaluation, registration, source seed production, seed multiplication, quality control; conditioning and storage, and marketing and distribution. Besides considerable investment and capacity building involved in either of these steps, some sort of regulatory framework exists in nearly all countries.

However, particularly if the public regulatory agencies are weak and lack resources, the insistence on formal certification may be a serious disincentive to emerging seed production initiatives. Tripp (2003), therefore, calls for a more flexible quality control system, based on agreed-upon standards and spot checks, and suggests that regulatory frameworks should strive to support, rather than restrict, emerging seed enterprises.

In many African countries, formal seed markets do practically not exist for staple food crops, with hybrid maize (besides cotton) being an important exception. Ndjeunga (2002) studied the pearl millet seed market in Niger, concluding that prior investments for establishing a formal seed market had largely failed. Less than 2% of the pearl millet seed used by farmers stemmed from the formal sector at the time the study was conducted, and (subsidized) seed prices represented less than one-third of the average cost of seed production. He, therefore, argues for strengthening local (informal) seed markets, particularly during drought periods, and for encouraging individual seed producers or groups of farmers in each community to become entrepreneurs tasked with the multiplication and distribution of new pearl millet varieties. A similar outlook is also proposed by Kaboré et al. (2009) for Burkina Faso.

However, Bentley et al. (2011) state that it may even be more difficult for smallholder seed producer groups than for private seed companies to collaborate with the public sector for source seed supply and certification services. Inadequate production of source seed is a major constraint in sub-Saharan Africa. Furthermore, producing good quality seed may be a key competence of many farmers, whereas this is not necessarily the case for running successful seed businesses. Farmer seed enterprises frequently lack access to adequate equipment, networks, credit, and very often the true production cost is above the sale price of the seed.

We can conclude that the emergence of commercial seed markets, with or without farmer producer groups playing an important role in them, is a long term task. Its success or failure depends on the availability of varieties that have advantages for farmers, the capacity of seed producers to deliver seed of high and reliable quality, the development of markets and the conditions for agriculture in general, and the degree of trust and ac-

countability that exists between market partners, as well as between them and the government institutions that set the regulatory framework.

BREEDING AND SEED SYSTEMS DEVELOP IN A 'FORCE FIELD' OF DIVERGING AND SHARED INTERESTS

Breeding and seed systems are multi-actor systems. The relations between these actors are characterized by shared as well as diverging interests and power imbalances. Table 2 lists (some) interests of various actors in seed systems.

Table 2: Shared and diverging interests of stakeholders relating to emerging commercial seed markets

Stakeholder	Interest(s)
Government	• Set rules to ensure food security and an adequate level and stability of agricultural production • Implement international agreements • Economic development of the agricultural sector
Plant breeders	• Produce varieties for which a demand exists among farmers • 'Feed' new varieties regularly into the seed market • Get adequate funding for scientific and practical work relating to variety development and fulfill expectations of donors/company
Seed producers	• Produce and sell a stable or growing quantity of seed of varieties for which demand exists • Transparency of rule and regulations they have to comply with
Seed traders	• Sell a set of known varieties for which demand exists over many years • Low risk and transaction cost
Farmers	• Additional option to get seed in case of need (depending on own stock, weather conditions etc.) • Sufficient quality of seed available in the market • Easy access to a set of improved varieties with various distinct/complementary characteristics • Affordable seed price • Profit from breeding progress to develop their farm and improve income
Food processors	• Profit from breeding process to optimize production process and increase value • 'Standardize' variety portfolio of producers to facilitate production process
Consumers	• Taste, storage and cooking quality of products • Nutritional and health aspects • Affordable food price

Besides a shared general interest of all actors to make available seed of varieties that are demanded for by farmers and fulfill consumer needs, there are also a number of diverging interests. Plant breeders, farmers and consumers share the interest to establish a continuous flow of material (seed) and information so that the varieties that best suit farmers' and consumers' needs are continuously being developed and produced. The interest of seed producers, food processors and traders is generally to limit the number of varieties used by farmers so that transaction costs and risk can be reduced. Replacing well-established varieties regularly with new, improved ones may appear as an additional cost factor, if not justified by additional benefits for them.

On the other hand, farmers and consumers share the interest of having a greater number of varieties for various purposes and needs at their disposal. Moreover, it is in general not a farmer's interest to buy seed exclusively and regularly from the formal seed market. If seed of preferred varieties can be reproduced on-farm without quality loss, it is usually much less costly than seed derived from a formal seed production chain. Farmers thus tend to see the formal seed market as an additional option that complements their own informal system of seed production and farmer-to-farmer distribution, and which they use in case of need. For example, it is often reported that farmers buy seed immediately before sowing, and chose the variety they sow according to the timing of onset of rains, among other factors.

Seed producers and traders, in contrast, are interested in selling seed to farmers on a regular basis, instead of fulfilling a highly fluctuating demand. That is why they often concentrate on varieties that cannot be reproduced easily on-farm (e.g. hybrid varieties), and for which, therefore, a more stable demand exists. Restricting the legal space for the informal seed market may appear as an option to shift demand and power towards the formal system in the longer term.

Lastly, the 'interest' of plant breeders is driven by their institutions and the source of funding. In commercial breeding and seed enterprises, plant breeders are usually expected to serve the commercial interest of the company, e.g. for profitably marketing seed and other agricultural inputs. On the other hand, plant breeders working in public institutions have to focus their work on public goods, including for example food and nutrition security, or farming system resilience (see further implications for seed system development below).

Acknowledging and conceptualizing the fact that breeding and seed systems develop in a 'force field' of diverging as well as shared interests and power imbalances is thus necessary to design adequate strategies and policies that support sustainable seed system development.

THE FUTURE DEVELOPMENT OF AGRICULTURE AND SEED SYSTEMS: A MATTER OF POLITICAL CONTROVERSY

Growing commoditization of seed and the development of commercial seed markets in Africa and worldwide is subject of a controversial political debate. As Bentley et al. (2011) state: "*The formal seed system is actually a marriage between the government and the private sector* […]". Thus, the needs, contributions and rights of farmers and local communities have seldom been considered in developing a political vision and designing the regulatory frameworks for seed commercialization, in Africa and elsewhere.

Civil society movements criticize that agricultural policies, particularly those concerning the seed sector, are often driven by the interests of commercial enterprises (Daño, 2007; Herre, 2008; Thompson, 2012; Clausing, 2013). However, states are first and foremost obliged to protect and promote their citizens' rights, including the Right to Food, to comply with obligations deriving from international agreements, and to set a regulatory framework that facilitates innovation, economic growth and sustainable development.

In his report to the United Nations General Assembly, the UN special rapporteur on the Right to Food, Olivier de Schutter, highlighted the importance of informal seed systems for food security of vulnerable groups. He emphasized that informal seed systems will continue to be marginalized if states do not take targeted measures to strengthen them. A focus on protection of intellectual property rights of plant breeders and commercial enterprises can impede, rather than enhance innovation in variety development and seed provision (De Schutter, 2009). The conservation and sustainable utilization of agrobiodiversity falls under the commitments made by countries in signing international agreements (e.g. CBD[1], ITPGRFA[2]). The articles 6 and 9 of the ITPRGFA relate to appropriate measures for promoting the sustainable use of genetic diversity. The participation of farmers is explicitly stated in Article 6, with the aim of developing varieties that are adapted to the so-

[1] CBD= Convention on Biodiversity
[2] ITPGRFA=International Treaty on Plant Genetic Resources for Food and Agriculture

cial, economic and ecological circumstances faced by farmers, particularly in the marginal areas of developing countries. It also calls for the creation of a broader genetic base for crop plants and the promotion of local species and varieties, particularly underutilized crops. It further states that breeding strategies will possibly have to be altered and the seed legislation revised to facilitate these measures. Article 9 refers to Farmers' Rights, including four aspects of these: (1) the right to save, use, exchange and sell farm-saved seed, (2) the protection of traditional knowledge, (3) the right to be involved in decision-making pertaining to the use of genetic diversity, and (4) the right to share in any benefits arising from the use of the genetic resources.

However, these 'rights' remain partly vaguely defined in the treaty, particularly with regard to the first aspect that touches on the interests of the commercial seed industry (Andersen, 2013a). She states: *"Despite the lack of precision, the general line of thought is clear: it is important that farmers be granted rights in this area although the individual countries are free to define the legal space they deem sufficient for farmers regarding their rights to save, use, exchange and sell farm-saved seed."* In the recent decades, the legal space of farmers in this direction has been steadily more restricted in many countries, with Norway and India being important exceptions (Andersen, 2013b; Winge et al., 2013).

The political debate around seed policies could also be seen in the wider context of an existing controversy on the direction of agricultural and food system development in general, and their importance for strengthening economies of developing countries. Opening agricultural markets for more (international) competition tends to force actors to more 'efficient' production methods, hence to increase specialization and scale of production units. According to Herre (2008), putting a strong focus on productivity gains in agriculture and employment in political strategies for agricultural development cannot be the solution to hunger and poverty reduction; this approach ignores the social and ecological costs that are associated with it, and continues to focus on increasing food availability, rather than clearly targeting the question of how access to adequate food can be secured for vulnerable people in a sustainable way.

A wider deployment of agricultural biodiversity is an essential component in the sustainable delivery of a secure food supply that adequately fulfills human dietary needs, and can increase the productivity and resilience of farming systems in a variety of growing conditions (FAO/PAR, 2011; Frison et al., 2011). However, agrobiodiversity does not seem to be an issue actively addressed in any of the current international initiatives proposed for agricultural development in Africa, including the 'Comprehensive Africa Agriculture Development Programme' (CAADP) and the 'Alliance for a Green Revolution in Africa' (AGRA).

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) attributes a crucial role to agroecology in shaping sustainable agricultural development (IAASTD, 2009). The concept of 'sustainable intensification' that has recently been promoted by FAO and other international organizations, however, is not a synonym for an agro-ecological approach, as it is quite narrowly focused on increasing food production. In order to contribute to sustainable development of food and farming systems, it needs to be treated simultaneously with other related policy issues, including for example preserving biodiversity, animal welfare, human nutrition and promoting rural economies (Garnett et al., 2013). Governments as well as international organizations will have to 'navigate' along these potentially conflicting issues and goals, and design more integrated, cross-sectoral policies to facilitate sustainable development.

A study that was presented by the research department of Deutsche Bank some years ago differentiates between a technology-centered approach and a system-based approach to developing agriculture and food systems. The former is described as input- and technology-oriented, whereas the latter places emphasis on system improvements, participation and capacity building. According to the study, both approaches have different impacts on societies. The system-oriented approach is better suited to counteracting inequality and reducing poverty as it creates fewer dependencies and spreads power instead of concentrating it (Deutsche Bank Research, 2009). It can be expected that both approaches will be promoted simultaneously by different actors and interest groups.

INTEGRATED SEED SECTOR DEVELOPMENT

Since the 1990ies, it has been proposed to better integrate informal and formal seed systems and improve the linkages between them in order to better serve farmers' needs and improve seed system resilience (Almekinders et al., 1994; GTZ, 2001; McGuire & Sperling, 2013). Formal and informal seed systems have different and in parts complementary characteristics (see Table 3).

Table 3: Complementarities of formal and informal seed systems for various criteria

Criteria	Formal seed systems	Informal seed systems
Outreach (scale)	limited	wide
Varieties offered	high yielding varieties of some major crops	mainly local varieties of a range of locally important crops[1]
Diversity of crops and varieties offered	low	high
Technical seed quality	usually high/standardized	usually high/variable
Seed price	high	low
Quality and relevance of information provided[2]	limited	high

[1]some varieties of the formal breeding sector may also circulate through informal seed systems
[2]from a farmer's perspective

Informal seed systems provide extensive networks reaching nearly every farmer – a fact that is often undervalued – whereas formal seed systems tend to have a limited outreach in many developing countries. The formal seed system concentrates on widely adapted varieties of a few major crops, while the informal sector offers local varieties of all crops grown in a certain locality. These varieties are adapted to the specific conditions of that location, and may be complemented with some varieties originally derived from the formal breeding sector. The diversity of crops and varieties tends to be higher in the informal seed sector. For example, seed of 'neglected' crops may not be available at all via formal distribution channels.

Technical quality of seed sold tends to be high in both systems for the majority of crops. It may vary in informal seed systems depending on season and storage methods applied. Furthermore, specific problems may exist with seed-borne diseases or virus infections in certain species, or in some vegetatively propagated crops. However, quality problems do also occasionally creep into formal seed systems (and if so, it is likely to happen at large scales) – so that there is no simplistic correspondence between 'formal sector seed' and high quality, or 'informal sector seed' and low quality. Seed producers, traders and customers in informal systems rely on personal trust rather than official 'labels'. Producers and traders in informal systems may take particular action to secure seed quality, for example by sourcing seed from particular fields and farmers, or by separating seed and food grain. The seed price is usually much lower in informal seed systems, as the necessary level of investment into labor, machinery, storage facilities, packaging, transport, distribution etc. is much lower (Bentley et al., 2011). Lastly, the information available along with buying seed is usually perceived more reliable and relevant from a farmer's perspective if seed is purchased from neighbors or relatives, compared to the information available from seed sellers in the market. Informal seed systems thus have many advantages from the farmers' viewpoint.

For the formal seed sector, there are several options to link up with informal seed systems and create new, complementary distribution pathways. Well known strategic activities to improve availability and access to improved seed for small-scale farmers are (1) to increase the number and proximity of seed outlets, (2) to reduce the size of seed packages, and (3) to facilitate access to information about relevant varieties for farmers and traders (Sperling et al., 2013). Small seed packages in particular facilitate experimentation and can be obtained at a price affordable to most farmers. Small seed packages can easily be sold at local markets and at general stores in villages. Mobile shops or specific outlets within the reach of marginalized groups are further options for 'multi-channel' distribution of seed.

Easy availability and access to seed enable farmers to quickly adapt their sowing patterns to variable climatic conditions, or in case of crop failure. Offering a set of varieties that has been tested and characterized locally for various and specific conditions helps farmers increase resilience of their farming systems under varying stress conditions (McGuire & Sperling, 2013). These authors further emphasize that physical availability of any seed is only as good as the information that guides its use. That is why short-term information (e.g. via radio or SMS on newly available varieties and seed) could be combined with a long-term approach to enhance context-specific and strategic learning and experimentation, e.g. by establishing networks of participatory variety evaluation trials. Not only farmers, but also local traders should have up-to-date and (local) context-related knowledge on varieties and their properties. However, concrete steps towards scaling up such approaches and institutionalizing them have remained largely unexplored (McGuire & Sperling, 2013).

On the other hand, it tends to be more difficult for farmers to create linkages between their informal seed systems and formal institutions and distribution channels, than *vice versa*. This may be due to the fact that the structure of the formal seed system and its organization through existing policy and regulatory frameworks widely ignore the relevance and value of the informal system and its products. They can even result in a dismantling of such traditional systems. Particularly the variety registration rules and seed legislation too often focus only on the commercial breeding and seed sector, and ignore that other, complementary, structures are also needed. Therefore, an integrated approach to seed system development has been proposed for creating coherence between policies, programs and practices relating to the provision of seed, and to balance public and private sector involvement (Louwaars & De Boef, 2012).

Variety registration and seed legislation

*A major obstacle for the registration of crop varieties from the informal sector are the so-called 'DUS criteria' defined by the International Union for the Protection of New Varieties of Plants (UPOV). These criteria have been defined as **d**istinctness, **u**niformity and **s**tability (UPOV, 2002). However, many landraces or landrace-based populations lack uniformity, which is in fact understood as an important aspect of adaptation to variable environmental conditions (see for example Haussmann et al., 2012).*

Farmer varieties may fail to meet these criteria. Moreover, in many countries varieties need to be tested in official multi-locational trials before being qualified for registration. The trial design does usually not reflect the conditions and needs of resource-poor farmers, so that the results may be of little relevance to them.

Variety registration as well as seed certification rules and fees can thus result in barriers for potential interaction between the formal and informal seed systems.

Louwaars & De Boef, 2012

These authors draw attention to the fact that publicly funded plant breeding in developing countries needs to be development-oriented in that it should serve public goods, whereas private breeding is market-oriented. The structural adjustments of the 1980ies and 1990ies, however, led to a withdrawal of the public sector from

seed production and distribution activities. As a result, the private breeding and seed sector took that part of the seed market that is commercially 'interesting', whereas weaknesses exist in seed delivery of varieties from the public breeding sector: *"Remaining and often weakened public breeding programs that are responsible for other major food (non-maize) crops are unable to disseminate their varieties to farmers upon release. The seed value chain for major food crops (other cereals, pulses, and oil crops) lacks the seed production component* […].*In many cases, NGOs began operating in this vacuum; in other cases, research centers chose to work directly with farmers in disseminating their varieties. Emerging small-scale seed enterprises, or local seed businesses, aim to fill this gap in the seed value chain for many food crops* […]*"* (Louwaars & De Boef, 2012).

They further highlight that even though the basic components are basically the same – breeding, seed production and marketing – development-oriented and commercial breeding and seed systems are fundamentally different. Insufficient appreciation of this difference is seen as an important reason for the failure of many attempts to commercialize the public seed production infrastructure. Whereas in development-oriented seed systems it is the breeding component that drives the chain, the marketing component takes the primary lead in commercial seed systems (see Figure 1). This fact results in each system focusing on different crops and variety types, and delivering different products and outcomes.

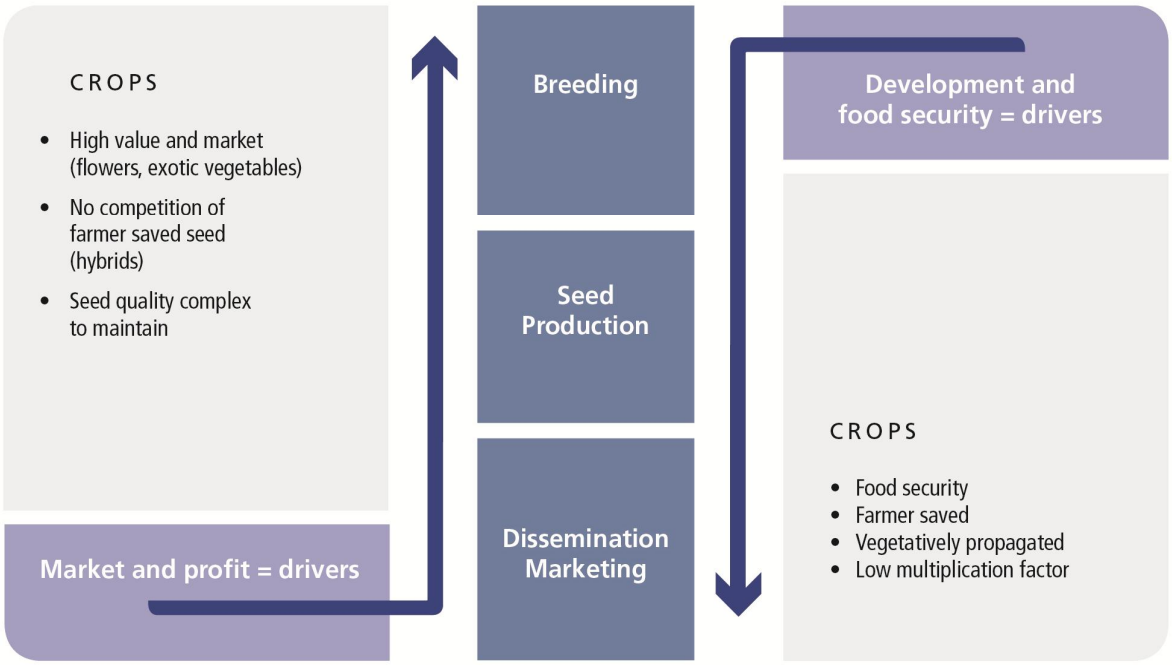

Figure 1: Different drivers and outcomes of commercial and development-oriented (public) plant breeding, seed production and marketing chains (Source: Louwaars & De Boef, 2012, adapted)

The basic idea of an Integrated Seed Sector Development (ISSD) approach is based on accepting that each chain can make particular contributions and has to play a role in the development of the seed sector. However, a more pluralistic view is required that may lead to promoting several complementary pathways to seed sector development. In practice, this means that a range of actors needs to be involved to cover diverse needs and marketing 'niches'. These actors may include, for example, private companies that operate at international or national level and focus on the requirements of more commercial farming enterprises, but also local seed enterprises or farmer groups that offer a range of varieties for local farmers' and consumers' needs.

The role of governments would be to design enabling policies that foster pluralistic approaches that allow seed sectors to develop. Along with societal actors, projects and programs could be designed that build on diversity

in approaches, goals and driving factors for seed systems activities (Louwaar & De Boef, 2012; Scoones & Thompson, 2011).

Innovation in seed systems may thus involve new arrangements and partnerships between actors of formal and informal systems and institutions. These may result in a change of practices beyond what has been known as either 'informal' or 'formal' so far. For example, where farmers engage in producing seed of varieties that require special knowledge and investment to be maintained and reproduced, this seed will need to have a price beyond the normal grain price, whereas this may not be necessary for some other types of farmer-produced seed. Practices originating from the formal seed system, such as variety registration and seed certification rules, may need to be revised to serve various actors' needs. Conceptualizing and positioning seed system innovation and development activities within the ISSD approach could help focusing them on achievable goals and clarify objectives among the stakeholders.

SORGHUM AND PEARL MILLET CROPS, VARIETIES AND SEED SYSTEMS IN WEST AFRICA

Sorghum (Sorghum bicolor (L.) Moench) and pearl millet (Pennisetum glaucum (L.) R. Br.), are the most important staple food crops in large parts of Africa. They are essential to diets of poor people in the semi-arid regions and parts of the sub-humid savannah-like areas of Sub-Saharan Africa, where other crops frequently fail under erratic rainfall conditions. In West Africa, sorghum and pearl millet together are estimated to account for 70% of the total cereal production. Both crops together are estimated to account for 75% of the caloric intake of resource-poor people living in these areas. This is why these crops are of high importance for food and nutrition security, health, poverty alleviation and food markets not only quantitatively, but also in terms of nutritional quality (Atokple, 2003; Obilana, 2003). Sorghum and pearl millet are generally used for food purpose in West Africa, and to some minor extend for beverages (local beer). Typical dishes are porridges made from dehulled sorghum and pearl millet grain.

Both sorghum and pearl millet have relatively high protein and mineral contents compared to other cereal grains; however, protein content and quality vary with yield level and agronomic practices, e.g. fertilization,, and mineral contents of grains depend on soil characteristics (FAO, 1995). Moreover, food processing is an important factor that determines the amount, quality and uptake of nutrients from food. For example, dehulling and milling reduce the availability of micronutrients, while malting and brewing can increase it.

Considerable genetic variation was found in ICRISAT's germplasm collections, with regard to protein content, amino acid composition, fat, mineral and vitamin contents. For example, iron contents vary by between 4 and 58 mg/100g in pearl millet accessions, and protein contents between 6 and 21 % (FAO, 1995). This genetic variation has not been fully exploited in the past, as breeding efforts were mainly focused on productivity improvements, with far less attention being given to nutritional quality enhancement (Atokple, 2003).

However, given the fact that under- and malnutrition prevails in the region, and the importance of sorghum and pearl millet for human diets, it appears crucial to take up a nutrition-sensitive approach to agricultural and food system development in the future. The number of undernourished people is estimated to be 9% in Burkina Faso, 12% in Mali and 20% in Niger, with micronutrient deficiencies ('hidden hunger') being much more widespread. Child malnutrition (stunting) is even estimated to be 35% for Burkina Faso), 38% for Mali and 46% for Niger (SWAC/OECD, 2011).

Pearl millet is grown as a staple crop throughout the Sahelian zone of West Africa, with annual rainfall ranging from 300-600 mm. All three project locations visited in Niger are located within this zone, with mean annual rainfall ranging from 310 to 490 mm/a. Sorghum is grown as a staple crop in the sahelo-sudanian zone, where annual rainfall is above 600 mm. Kaya in Burkina Faso is the driest among the study locations focusing on sorghum, with average rainfall ranging from 500-650 mm/a, whereas the other locations in Burkina Faso and Mali all receive more than 750 mm/a on average.

The region is characterized by high inter-annual rainfall variability, with variable onset of the rainy season, somewhat more predictable endings, and drought or excess water occurrence at any time during the growing season (Haussmann et al., 2012). Climate change is predicted to increase this variability. As anthropogenic climate change interacts with the high inter-annual variation which is typical for the Sahel region, and with medium-term cycles of dryer and wetter periods, the effects are difficult to predict and the magnitude, timing and direction of future rainfall variability patterns are uncertain (Haussmann et al., 2012).

However, farmers display a high level of knowledge and awareness of climate change and how it affects their livelihoods. The major climate change indicators reported by farmers included increased temperatures, delayed onset of rains, and insufficient levels of rainfall. They described the major consequences as: lower yields, drop in ground water levels, loss of biodiversity, reduced soil fertility, increased wind and water erosion, decreased quantity of rainfall, and poor rainfall distribution. Other consequences mentioned by farmers included flooding, abrupt ending of the rainy season, decreased area of grazing land and higher incidence of hot winds, and changes in surface water quantities such as drying of rivers, ponds, or wells (ICRISAT, 2009).

The area under cultivation has increased substantially for sorghum and peal millet crops over the last decades. In Mali, Burkina Faso and Niger alone, the area cultivated with sorghum increased by nearly 90% from 1980 to 2010; in the same period the area cultivated with pearl millet increased by 65% (data from FAOSTAT). This dynamic growth underlines the importance of these crops for the local food systems and economy, particularly in view of the human population growth that is prevalent in these countries. Annual population growth rates of 3 % (Mali, Burkina Faso) and 3,5% (Niger) are among the highest in the world. Nearly half of the population is below 15 years of age. The total number of people living in Mali, Burkina Faso and Niger is predicted to increase from 47,7 million people in 2010 to 144,2 million in 2050 (SWAC/OECD, 2011). These figures emphasize the importance of and need for developing more productive and efficient agricultural and food systems in this region.

Average yield levels differ between the three countries, thus reflecting the different agro-ecological conditions. In Niger, the yield level of pearl millet is higher compared to sorghum, in contrast to the situation in Mali and Burkina Faso. For the past three decades, a clear trend towards increasing peal millet and sorghum yields per area can only be demonstrated for Burkina Faso (Figure 2). In Mali, average yields of both crops are variable but do not show a trend (= a linear trend line has no slope). In Niger, a very slight increase can be observed for pearl millet yields, but on a very low yield level.

Sorghum and pearl millet are typically grown in rainfed conditions in West Africa. The most important constraints to production are water scarcity due to the highly variable rainfall conditions, poor soil fertility (particularly low phosphorus availability), and biotic stresses, such as striga (*Striga hermonthica*, a parasitic weed) or insect pests.

Breeding plays a crucial role in addressing these constraints, particularly in low input farming systems of the semi-arid tropics. In contrast to high input farming systems, where environmental conditions can be to some extent *controlled* by farmers by applying purchased inputs, such as fertilizers, pesticides or irrigation water, low external input systems rely on complex management decisions taken by the farmers with the aim to *adapt* to environmental conditions they can basically not control (Kaufmann et al., 2013).

Flexible use of a range of crops and varieties, as well as altering planting areas of various crops according to 'indicators' observed by the farmers, are typical adaptation strategies. That is why farmers working under low input conditions are generally highly interested in new plant varieties, particularly those showing new and complementary traits. For example, many farmers adopt short-duration varieties from formal breeding programs and use them as a complementary option, besides their traditional varieties.

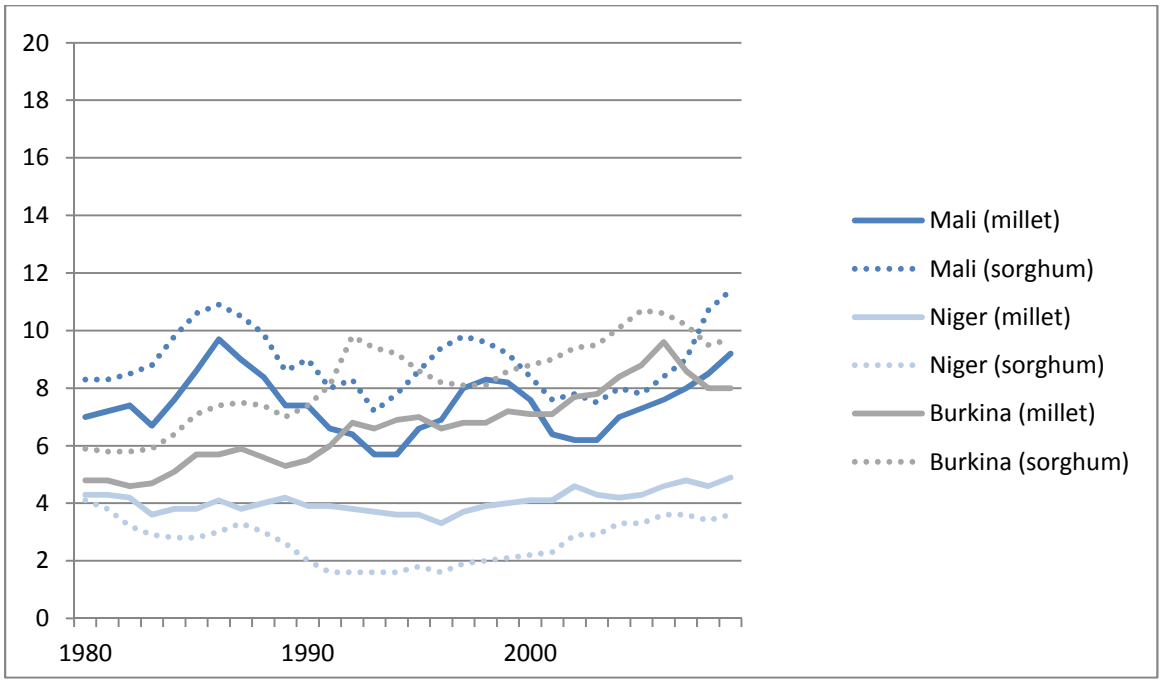

Figure 2: Development of sorghum and pearl millet yields per area [dt/ha] over three decades for Mali, Niger and Burkina Faso (data: FAOSTAT; 3-year moving averages)

In view of abiotic and biotic stresses, farmers working under such conditions tend to rely on the inherent 'buffering capacity' of many traditional landraces. Besides having specific adaptive traits, e.g. tolerance to heat or low soil fertility, these varieties also show a plastic response to stresses such as variable rainfall conditions. Haussmann et al. (2012), for example, demonstrated that photoperiodic sensitivity, as well as genetic variability with regard to flowering dates, can be important traits for enhanced adaptation to changing and variable climatic conditions. As water scarcity also limits the effectiveness of fertilizer use, varieties that are drought tolerant *and* respond to improved soil fertility management are very important for increasing productivity levels in the longer term. Plant breeding is also important to reduce the effects of biotic stresses limiting production. Exploiting existing genetic variation with regard to striga or insect pest tolerance is a promising way of reducing losses. Emphasizing the importance of plant breeding does, however, not mean that other practices, such as agronomic measures to control pests, reduce erosion, improve soil fertility or increase water infiltration, are not important. All these measures together can help make low input farming systems more productive and resilient (see, for example, ICRISAT 2009).

Figure 2, however, shows that such integrated improvement strategies, of which breeding progress should be an important element, have not reached farmers' fields at a relevant scale over the past decades, particularly in Niger and Mali. Even though the dynamic expansion of areas planted may include marginal areas, the data show that research and practical breeding efforts in the past seem not to have addressed the conditions faced by the farmers in a satisfactory way.

This is also reflected in the fact that the farmers' adoption of varieties from the formal sector has remained rather low, even though some studies suggest relatively high yield gains for 'improved varieties' of sorghum and pearl millet in West Africa. For example, a synthesis from various adoption and impact studies documents yield gains of 22% in Niger and over 50% in Mali (Camara et al., 2006). However, it remains unclear whether these figures are derived from farm level measurements, variety trials or other sources. Various improved varieties of sorghum and pearl millet were used by 20 -50% of rural households (depending on which variety) in Niger and Mali, and less in Burkina Faso. Based on the area sown, 30% of sorghum area and 37% of pearl millet area in Mali was reported to be sown with improved varieties in 1995. Throughout West Africa, improved sorghum varieties are estimated to be grown on 30% of the total area sown with this crop (ICRISAT, 2004).

Yapi et al. (2000) state that sorghum and pearl millet breeding in Mali had focused on two different approaches: (1) Selection in local landraces and (2) introduction and use of exotic germplasm. Both approaches resulted in a number of varieties developed. The main achievement of the second approach is shorter duration of some varieties, compared to the local landraces. The majority of improved pearl millet and sorghum varieties adopted by the farmers were, however, derived from local landraces. The farmers' preference for theses varieties is due to environmental adaptation, grain quality and high stover yield, in spite of their lower (grain) yield potential. Yapi at al. (2000) conclude that *"finally, it must be highlighted that although the estimated adoption rates of improved varieties are substantial, age-old landraces of sorghum and pearl millet still remain dominant in farmers' fields."* The calculated adoption rates were roughly between 15-20 % in this study for sorghum, and 5-25% for pearl millet (with regional differences).

In this situation, the Participatory Plant Breeding (PPB) approach taken by ICRISAT's sorghum and pearl millet breeding program since 1998, implemented together with the national breeding programs, seems to be well justified. PPB projects start from the assumption that farmers have their own complex set of goals, priorities, values and skills relating to seed selection and use, that may be complementary to the standard approach to variety development that assumes production efficiency and market-based value addition are the main goals of crop improvement. Furthermore, plant breeders have sophisticated knowledge of breeding technologies, but often lack context-specific knowledge, e.g. on typical constraints faced by resource-poor farmers, or relating to the utilization of the crops in the local context. Initiating dialogue and combining the expertise of farmers and researchers could thus lead to more relevant outcomes of plant breeding programs, particularly for poor farmers working in marginal environments (Bellon, 2006; Hoffmann et al., 2007). By actively participating in the decentralized evaluation and selection of varieties, farmers gain new, contextualized and location-specific knowledge about different varieties and their relevance for food and farming systems. This is an important prerequisite for creating sustainable demand for seed of new varieties, as mentioned above.

One objective of a recent impact assessment study was to update the analysis conducted by Yapi et al. (2000), but also to focus on the recent directions in Mali's sorghum breeding program. The first is the participatory approach to sorghum improvement, based on a network of multi-locational, farmer-managed field trials. The second is the development of the first Guinea-race, photoperiod-sensitive sorghum hybrids. The analysis consists of two components: (1) a census of sorghum variety and hybrid seed use parameters, covering 60 villages where farmers have tested materials; and (2) an *ex ante* assessment of the economic impact of sorghum hybrids, based on an economic surplus model (see section on 'Efficiency' on p. 25 for the latter; Smale et al., 2014).

In the target villages, the total of all improved varieties and hybrids used by farmers has increased to 46%. Hybrid use rates averaged over 7% of new seed types planted by farmers. In the initial year of use, only a small percentage of new seed types were purchased for cash, regardless of the variety type. Since initial use, the mean area planted per farmer has increased for all sorghum variety types, but this is especially true for hybrid seed, which now averages 2 ha per hybrid grower. Thus, there is evidence that farmers integrate the newly developed varieties and hybrids into their variety portfolio, and that the pace of adoption is much faster than in the past. Both improved varieties and hybrids are increasingly grown by the farmers.

Thus, establishing a network of participatory breeding and partly farmer-managed evaluation trials has resulted in the identification, enhancement and release of sorghum and pearl millet varieties and hybrids that perform consistently better than local varieties over a wide range of production conditions. Improving yields and yield stability while maintaining grain quality, selecting varieties specifically adapted to low soil fertility, improving post-harvest traits and nutritional quality, as well as tolerance to striga are some of the main issues addressed, for which progress has been achieved – with regard to the strategic orientation of the breeding programs, and to practical outcomes (Diallo, 2011; Leiser et al., 2012; Haussmann et al., 2012; Rattunde et al., 2013; Kountche et al., 2013).

With the availability of varieties from the public breeding sector that were attractive to farmers, the need arose to create the structures necessary to diffuse the seed. Given the absence of a public seed sector that links public breeding system to its customers (as described above), and the farmer organizations being already partners in the variety evaluation trials, their involvement in seed production seemed obvious. Previous experience existed already in some of the farmer organizations, particularly in Burkina Faso, where it has been common that farmer organizations produce seed as part of a government seed provision scheme.

A major challenge to be addressed was that seeds of local grains have not historically been considered economic goods in the project region – seeds are not something to be sold, though non-formal seed transactions are common (Ndjeunga, 2002; Smale et al., 2008; Siart, 2008; Smale et al., 2010). Establishing formal markets and cash-based sales seemed potentially unaligned with habits and history in Sahelian seed systems. Jones (2014) found that diverse seed systems co-exist in the West African region, and describes the multiple actions taken by farmers to access seed. Important to see is that the most important ways for seed provisioning are *not* based on any sort of 'commercial' value ascribed to it: For farmers, seed is primarily a result of their direct interaction with the natural environment, resulting in the possibility to harvest grain – and seed. Furthermore, sharing seed is an important way of accessing seed based entirely based on social relations. Furthermore, a number of exchange-based activities, including selling for cash, are also present in informal seed markets.

If farmers buy seed of formal sector varieties, they tend to recycle it over several years and also use it for various informal seed transactions. In this way, the various seed systems nowadays tend to be integrated by being connected and showing some degree of overlap, rather than one system being replaced or incorporated by the other.

Seed spread of formal sector varieties can thus not be captured based on seed sales only: *"The diffusion of improved varieties begins through formal exchanges, since implicit in the definition of the type of seed is the type of access activity used to diffuse the seeds. However, secondary seed spread occurs over a much wider range with informal and non-formal seed exchanges"* […] (Jones, 2014).

Current approaches to fostering agricultural development in Africa tend to emphasize seed value chain development and market-oriented formal seed systems as a priority for increasing agricultural productivity and food security. The seed value chains envisioned as a key feature of the second 'Green Revolution for Africa' reflect a general approach to 'integrate' small-scale farmers into global markets and value chains, with little attention being given to potential adverse or exclusionary effects (Jones, 2014). Or as stated by the same author: *"The rhetoric of market-oriented agricultural development implies that scientifically and economically efficient approaches to agriculture are unequivocally preferable to 'unimproved' or non-market based decisions and systems. This rhetoric can lead to an either/or framing of current and changing economic and agricultural systems, in which traditional and also adaptive actions by farmers and communities are evaluated simply based on whether or not modern practices and technologies are present in singular form."* (Jones, 2013)

With this push toward market-oriented seed value chain development, there have been efforts to harmonize seed laws at the national and regional level in order to avoid disincentives to cross-border seed trade. The seed laws that were recently passed, and which reference international standards, effectively tie all sanctioned seed system changes to the dominant value-chain approach to agricultural development (INSAH, 2009).

'Regulation C/REG.4/05/2008 on the Harmonization of the Rules Governing Quality Control, Certification and Marketing of Plant Seeds and Seedlings in the ECOWAS[3] Region' involves the development of a joint variety list and seed certification standards. The implementation of this regulation is supported financially by USAID, and linked to other initiatives, such as the West African Seed Alliance (WASA) via the West African Seed Program (WASP), the Permanent Inter-States Committee for Drought-Control in the Sahel (CILSS), and the Comprehensive Africa Agriculture Development Program (CAADP) established by the African Union. The intention is to

[3] Economic Community of West African States (ECOWAS)

build up an 'Alliance for a Seed Industry in West Africa' (ASIWA), and to implement the ECOWAS seed regulations in the national seed legislation of all member countries.

Whereas the joint variety list could make variety registration from breeding programs easier, a problematic aspect is that the ECOWAS seed regulation largely ignores the existence and importance of the informal seed system. 'Quality seed' is being associated only with seed originating from formal breeding programs, and agrobiodiversity issues seem to be completely out of consideration. This concept stands in sharp contrast with the reality of small-scale farmers in the West African region, and its impact on the emerging seed markets, and particularly farmer-managed seed initiatives, remains to be observed.

Civil Society organizations criticize that the ECOWAS seed regulation is not compliant with commitments made by the West African countries (including Mali, Niger and Burkina Faso) by signing the International Seed Treaty (ITPGRFA), which recognizes the contributions of farmers and farming communities to the conservation and development of crop genetic resources and Farmers' Rights. The African Centre for Biosafety, for example, blames the FAO and the CG Centers for inconsistent actions regarding seed and biodiversity issues, and a lack of commitment to actively promote the goals of the International Seed Treaty (ACB, 2012:29). The authors further warn that the strict implementation of the ECOWAS seed legislation and similar initiatives may lead to severe loss of genetic diversity in Africa.

We can thus conclude that the context in which the CCRP project on farmer-managed seed initiatives was implemented is highly complex and subject to changes. Present developments in the seed sector of West African countries are shaped by diverging interests, and it is still the question how they will be linked to related fields, such as genetic diversity conservation, Farmers' Rights and the Right to Food, and how the formal registration and certification procedures will be implemented and controlled.

4.2 FUNDING OBJECTIVES, PROJECT DESIGN AND THEORY OF CHANGE

FUNDING OBJECTIVES OF THE COLLABORATIVE CROP RESEARCH PROGRAM (CCRP)

The overall vision of the McKnight Foundation's Collaborative Crop Research Program (CCRP) is *"a world in which all people have access to the nutritious food they need on the terms they can afford, and where food is sustainably produced in ways that protect local resources and respect cultural values"* (McKnight Foundation, 2011).

In order to achieve this goal, the CCRP is used as an instrument for supporting and advancing collaborative research on Agro-Ecological Intensification involving smallholder farmers, researchers and development practitioners. The CCRP takes a place-based approach, so that grantees become members of four larger 'communities of practice' based in West Africa, Southern Africa, East and Horn of Africa, or the Andes (CCRP, 2014).

> *"The people of McKnight foundation really care about their projects. If there are problems or needs, for additional capacity building let's say, they do everything they can to make it possible. This is a big difference to other funding organizations."*
>
> *(A scientist)*

A strong focus is on capacity building and knowledge sharing between all groups or organizations involved. Towards this end, each 'community of practice' is supported by a regional team, consisting of a regional representative, a liaison scientist, a monitoring and evaluation specialist, and a research methods specialist. The tasks of the regional team includes developing strategies, supporting proposal development, building relationships and helping stakeholders connect to each other to foster collaborative learning, also via annual meetings and workshops (CCRP, 2014).

With a commitment to continuous learning, the CCRP has created and implemented an Integrated Monitoring, Evaluation and Planning approach (IMEP), which helps actors in projects understand achievements and needs and adjust objectives and activities, and to mobilize necessary resources accordingly. The CCRP further supports the development of research methods for collaborative research approaches (CCRP, 2014).

In West Africa, the 'Community of Practice' focuses on improving food and nutrition security of smallholder farming families in Niger, Mali and Burkina Faso. It is striving for improving variety development of important food crops with regard to productivity and nutritional value, strengthening seed distribution systems, improving agronomic practices, amplifying and diversifying value chains, and improving diets and nutrition of farming families. A list of completed and ongoing projects is available under http://ccrp.org/west-africa.

The focus on transdisciplinary, collaborative research and capacity building is a distinctive feature of the CCRP among other research funding organizations working in the region. Since the program's inception in 1983, the McKnight Foundation has committed over 100 million US $ to the CCRP, of which roughly three quarters have been assigned to project grants. More recently, the CCRP has expanded its activities via partnership with the Bill and Melinda Gates foundation that contributed 50 million US-$ to the CCRP in the period 2008-18 (Cady, 2013; McKnight Foundation, 2014).

PROJECT DESIGN

The CCRP project 'Sustainable seed supply: Farmer managed seed marketing initiatives for sorghum and pearl millet in Mali, Burkina Faso, and Niger' was started in 2006 (2006-10); the second phase (2010-14) is presently nearing completion. A third project phase has been applied for.

The project was implemented in three countries, Mali, Niger and Burkina Faso, and focused on two different crops, sorghum and pearl millet. The project was jointly implemented by ICRISAT, the National Agricultural Research Organizations (NARS) of all three countries, and a total of six farmer organizations initially.

The starting point of the project was that a number of varieties had emerged from collaborative breeding and variety evaluation activities that were better adapted to farmers' conditions and needs than other varieties developed previously under high-input conditions on research stations. These new varieties were in high demand by farmers. The practical aim of the project was thus to develop an approach to commercial seed production of farmer-preferred varieties in collaboration with the farmer organizations.

The project design can be summarized under objectives, activities and expected outputs, as presented in Table 4a for the first and Table 4b for the second phase. Whereas the first phase focused on practical activities for increasing farmers' capacities to produce seed, monitor seed quality and strengthen demand, the second phase focused und deepening understanding of certain aspects of seed systems and to adapt the approach taken accordingly. These aspects included gender differences relating to women's and men's possibilities to access seed, and possibilities to improve dissemination of knowledge and seed of new varieties.

Whereas the outputs of the first phase were strongly related to the concrete activities around seed production and marketing, the second phase outputs relate to development issues, such as increasing stability of production (systems) and improving nutritional status of vulnerable groups.

Table 4a: Objectives, activities and planned outputs of the CCRP seed system project for the first phase

Phase 1		
Overall objective: To contribute to the development of sustainable seed systems by strengthening farmers' seed commercialization initiatives in Niger, Burkina and Mali.		
Specific objectives	**Activities**	**Outputs**
To strengthen the capacity of farmer groups, networks and seed cooperatives to produce and distribute increasing quantities of quality seed of a range of sorghum and pearl millet varieties in Mali, Burkina Faso and Niger	Each working group (in each country) of this project will prepare an analysis of the local seed system currently in use. Each working group will similarly establish an overview of present grain marketing practices, and experiences of farmers and their trading partners in the target zone. Each farmer cooperative will establish in the first year an initial organizational plan to assure that all key responsibilities of a future seed business are clearly integrated into a single structure.	Farmer cooperatives will 1) Conduct their own variety trials, so that they can identify regularly new varieties for distribution in their zone 2) Produce good quality seeds of a range of cereal varieties, with a satisfactory level of genetic purity 3) Commercialize seed of this range of different varieties to meet the needs of the farmers in their target zone.
To develop the means and capacities for sustainable monitoring and verification of seed quality.		1) The seed sold by the farmer cooperatives satisfies the needs of the users with respect to physical quality and varietal purity. 2) The costs for monitoring and controlling quality and varietal purity are acceptable, so that they can be covered by the price of the seed. 3) The seed cooperatives will have established a good reputation for the quality and purity of the seed they put on offer, as well as for the stability of the varieties on offer.
To strengthen the linkage of the farmer seed distribution networks with grain processing industries, and large-scale wholesalers, and thus increase demand for seed.		Farmer cooperatives will have improved 1) Their overall business and marketing skill 2) Their understanding of options for new developments in the grain market.

THEORY OF CHANGE

The project has developed a 'Theory of Change' that makes project outcomes and impact pathways explicit. The 'Theory of Change' relates changes in the seed system to more general development outcomes:

- Improving productivity, yield stability and income
- Enhancing access to and utilization of improved varieties
- Reducing malnutrition

The project aims at achieving this by making available improved varieties to women and men farmers, developing knowledge and methodologies for variety diffusion and by strengthening the capacities of farmer organizations to produce and sell seed. Research questions relating to these issues can be summarized under the three aspects of seed system security – availability, access and utilization (see Box 1, p. 3).

The 'Theorie of Change' thus focuses on the research project and the actors directly involved in the planned activities (researchers, farmer organizations and farmers). It describes how these actors could contribute to the desired outcomes by creating knowledge, joint understanding and capacity building.

Table 4b: Objectives, activities and planned outputs of the CCRP seed system project for the second phase

<table>
<tr><th colspan="3">Phase 2</th></tr>
<tr><td colspan="3">Overall objective:
The project seeks to strengthen the dynamics of local social seed networks so as to improve local seed availability and thus increase the adoption of new sorghum and pearl millet varieties for improved food security and income.</td></tr>
<tr><th>Specific objectives</th><th>Activities</th><th>Outputs/outcomes</th></tr>
<tr><td>Improve women (and men) farmers' access to seed of new sorghum and pearl millet varieties in targeted regions of Niger, Burkina Faso and Mali.</td><td rowspan="3">Women's engagement in quality seed production and possibly marketing will be initiated.

Work on methods and tools for better variety evaluation by farmers and farmer associations, including a reliable assessment of the quantity of food produced per unit area of harvested crop will be pursued.

Methods and tools for communicating the results of individual site variety evaluations at an appropriate scale will be developed.

Monitoring will focus on the variety adoption process, including yearly changes in variety use, and shall contribute to understand farmers' (female and male) responses to climate variability and other changes in the external environment.

National scientists will provide seed of new varieties for testing and ensure that varietal evaluation and monitoring results are collected and used.

They will also assure that foundation seed is available for seed producers and facilitate seed certification.

Training and exchange activities will be coordinated within each country by a local coordinator based within one of the partnering farmer organizations.

The farmer organizations will continue to improve their seed marketing skills through needs-based training programs (e.g. seed certification, seed marketing, enterprise development).

Each country team will hold appropriate planning meetings in the target zones, and define options for seed dissemination for testing.</td><td>Contribute to improved seed availability in the target areas as well as in similar agro-ecologies in the participating and neighboring countries.</td></tr>
<tr><td rowspan="2">Understand and enhance the effectiveness of different activities for enhancing seed availability and knowledge about the new varieties.</td><td>Improve productivity and/or stability of production of pearl millet and sorghum in the target areas.</td></tr>
<tr><td>Working with women farmers and with varieties possessing elevated iron and zinc concentrations should also enable the project to contribute to improved nutritional status of young children.</td></tr>
</table>

However, other influencing factors that could support or hamper the change process the project is striving for are not addressed with any targeted activities. For example, a more general stakeholder analysis and analysis of external factors that may support or hinder the change process has not been included, and the involvement of these other stakeholders in the research process appears to be limited to their official functions or institutional relationships they may have with ICRISAT and the national research institutes, or to informal contacts that may exist between the various actors and these stakeholders.

BOX 1: IMPORTANT RESEARCH QUESTIONS ADDRESSED IN THE PROJECT

Research questions targeting seed availability (production)

- How can farmer cooperatives most effectively chose varieties for multiplication and diffusion (evaluation methodology)?
- What is the effect of seed production and diffusion on productivity (and yield stability, income)?

Research questions targeting access to seed (demand)

- Basic studies on functioning of seed systems in the target region (including gender aspects)
- Which factors influence adoption of varieties and demand for seed?
- How can commercialization of seed be organized at the local level and supported by capacity building?

Research questions targeting seed utilization (quality aspects)

- How do post-harvest quality traits influence variety adoption ('food yield' as an important criterion, particularly of women farmers)?
- Conditions for adoption and utilization of 'biofortified' varieties (rich in Fe/Zn), particularly by women
- Gender roles and their implications for seed and variety utilization - how do project activities change dynamics of traditional seed networks and variety use?

4.3 GENERAL RELEVANCE OF THE PROJECT

The relevance of the project can be described as the way in which it relates to the priorities and policies of the stakeholders involved, for example the funding objectives of the donor, the objectives of the research and farmer organizations, and the farmers in the project areas.

In general, the project is relevant as it suggests solutions to prevailing problems of agricultural food and farming systems in the West African region, including stagnating agricultural yields, climate variability and change, scarcity of resources, population growth and malnutrition. Developing access to varieties of staple food crops that are adapted to farmers' needs, help increase and stabilize agricultural production, improve access to staple food and address nutritional problems can be considered highly topical in this context.

All organizations involved in the project relate their activities to these challenges. The project builds on a shared vision of the actors for developing innovations in the seed systems of West African countries that are driven by farmers' needs and with them being important actors in the emerging seed value chains. The core activity on which it is based is the joint development and evaluation of varieties from the public breeding programs that are highly relevant to farmers and help them improve the productivity of their farms and increase their income.

The project has thus been designed to address a clear issue: securing farmers' access to quality seed of preferred varieties by tying participatory breeding and variety evaluation to seed enterprises managed by farmers. Besides facilitating the 'flow' of breeding progress from public breeding programs to farmers' fields, this approach also offers the opportunity that at least some groups of farmers profit from the economic value addition involved in a formal seed production chain, instead of just paying for it. That is why the project has a potential to increase incomes of farmers,

"Everything is in the hands of farmers: from production of seed, even of source seed, to processing, packaging and commercialization."

(Farmer group in Niger)

not only through improving the crop yields, but also by creating a new sources of income in seed production, processing and marketing.

The project is implemented in an institutional setting involving multiple stakeholders that are all engaged in the issue, but in different sectors, including government, private and civil society sectors. Thus, uniting the diverse actors along the seed chain is one of the major challenges: small-scale farmers, farmer cooperatives, private enterprises, national and international research institutions, government agencies. The project aims at setting up a new and sustainable cooperation between them, and at creating a viable economic base for seed system development.

The project is also relevant from scientific points of view. A number of studies on traditional seed systems have been completed that describe their strengths and weaknesses and how they are embedded in social systems. Most of these studies conclude that traditional seed systems become weaker and social cohesion more fragile, and call for 'building bridges' between the formal and the informal systems to improve farmers' access to new varieties and breeding technology. Seed system development is regarded as an important bottleneck for the success of participatory breeding initiatives, and public breeding programs in general. However, developing seed systems is a long-term task that generally involves organizational, political and economic challenges that go beyond the scope of most breeding programs, thus limiting their success and impact. The CCRP-funded project on farmer-managed seed initiatives in West Africa provides an important link to address this challenge.

With its focus on food security, multi-stakeholder collaboration, capacity building and learning, the project appears to be well suited to the objectives and general approach of the CCRP, and clearly relates to the idea of establishing a 'Community of Practice' involving multiple stakeholders. Moreover, it is also strongly connected to the concept of 'Agro-ecological Intensification', as it was defined for the CCRP, and to the idea of 'contextualized scaling' that is mentioned there. In fact, building up farmer-led seed enterprises is a possibility to scale up variety adoption from breeding projects that were also (partly) funded by the CCRP, and which are part of its broader approach to improving productivity of farming systems based on agro-ecological principles.

The CCRP is also very much in line with recent developments in the CGIAR research system, where research aims increasingly towards development outcomes. Very recently, a workshop organized jointly by the CGIAR and GIZ aimed at tackling questions of demand-driven research, uptake and adoption and partnerships for development impact in the larger context of innovation processes (GIZ, 2013). The 'Feldafing Principles' summarize the discussions and focus on innovation as being a multi-dimensional, multi-stakeholder and long-term process that requires building spaces for dialog and joint learning and involves strategic capacity building for the different actors involved in the innovation process. However, that this form of research for innovation and development needs re-orientation not only with regard to research topics but also to methodologies remains to be fully conceptualized. The CCRP could thus be an adequate and qualified partner for implementing and supporting this new type of research.

4.4 SEED SYSTEM DEVELOPMENT

In this section, we document our findings on how the project contributed to developments concerning the various aspects of seed system security: Quality, availability and access to seed. We will start with the quality and utilization aspects, as these relate to the breeding and variety evaluation activities based on which the seed production activities were started. We will then present findings on seed availability and seed access in the seed systems of the study area.

SEED QUALITY AND UTILIZATION

Quality as one aspect of seed system security includes various issues: (1) the properties of the varieties of which seed is being made available through the seed system, for example with regard to their usefulness to

improve productivity and resilience of food and farming systems, or for meeting the nutritional requirements of consumers; and (2) the technical quality of the seed (e.g. varietal purity, germination capacity, absence of seed-borne pests and diseases).

According to farmers, the project activities have strongly contributed to increasing availability of useful varieties in the seed system. Here, the farmers did not clearly differentiate between the multi-locational testing and variety evaluation system on the one hand, and the seed production and marketing activities on the other. In fact, both activities offer farmers' the possibility to get seed of the new varieties that emerged from the collaborative breeding program. These are adapted to the agro-ecological conditions, provide higher and stable yields, are drought tolerant, in some cases resistant to *striga*, have good processing quality and taste and often a shorter duration from sowing to maturity. Farmers can harvest more from the same area and with more or less the same input. The early varieties can be harvested at least one month (4-6 weeks) earlier and still combine this advantage with many other preferred traits. This is important to reduce the 'hungry period' before the harvesting period.Hybrid varieties of sorghum, developed recently by IER and ICRISAT, have a clear yield advantage also under low-input conditions. Altogether, these advantages were reported to help families adapt to new (or old) challenges: Climate change, poor soil fertility, more cash requirements to pay for necessary services and goods (e.g. medical care, education, housing, mobility, communication).

The farmers further appreciate that the number and diversity of varieties available to them has increased. They use different varieties for different purposes and conditions and welcome the flexibility provided by new varieties that are now available. Many farmers use traditional, improved and hybrid varieties flexibly to profit from better yields and reduce risk. Multi-locational trials and participatory variety evaluations in villages, including culinary quality tests, attract the interest of many villagers also beyond the members of farmer cooperatives and help identify the most promising varieties. Varieties that go into seed production are all registered officially, once they have been selected by the farmers. Preferences vary widely among people from different villages, so that the diversity of options available and the decentralized approach are valued.

One disadvantage mentioned was that some new sorghum varieties are more easily attacked by storage pests, compared to traditional varieties. This applies to grain as well as stover, the latter in the case of some new sweet sorghum varieties. Except the open-pollinating ('line') varieties of sorghum, other varieties, like open-pollinating pearl millet varieties, or sorghum hybrids, lose their distinctive properties after one or several growing cycles.

The technical quality of seed sold by the farmer cooperatives is considered reliable by the farmers. This judgement is in line with a study in which technical quality of seed obtained from farmers in the project area was tested. It was found that seed quality was in accordance with official standards in most cases (Diallo, no year). In general, the farmers tend to rely more on their own assessment of seed quality and the trust they have in the people providing seed than on stamps or certificates bestowed by government agencies. That is why the farmer seed cooperatives have an important competitive advantage with regard to trust, at least where they operate in their own local environment, where people know the cooperatives and their members. Nevertheless, all farmer cooperatives sell certified seed only, because it is required by the new seed legislation, and also because it is a requirement of some customers (e.g. NGOs, aid organizations).

Given the fact that only a small share of seed used by farmers stems from the formal system to date, it is an important issue to be addressed how government institutions could gain or restore confidence while keeping pace with the increasing formalization of the seed market that is to be expected under the new seed legislation. Sealing of bags and packages, for instance, is not commonly applied or it is done in a way that it can easily be faked or imitated. Agro-dealers do not generally enjoy a good reputation with regard to the quality of seed sold by them. Lack of trust in government institutions and other market actors was particularly pronounced in Niger, and less pronounced in Burkina Faso and Mali.

Thus the issue needs to be addressed how stakeholders along the seed chain could cooperate in establishing an efficient and transparent system to ensure technical quality of certified seed that supports emerging seed initiatives and is known and trusted by farmers.

AVAILABILITY AND PRODUCTION OF SEED

It is the consentaneous opinion of all people who contributed to our study that the project contributed substantially to increasing the availability of seed of improved varieties in all three countries. The figures provided by the farmer organizations and in reports show that the total amount of seed produced increased, as well as the number of varieties available to farmers. In Niger, for instance, only one improved pearl millet variety (HKP) was widely available before the project started. Now, 3-4 more varieties are being produced by the farmer organizations.

The time since the farmer organizations have started engaging in seed production and marketing varies. Some had started seed production before this particular project. For example, AMSP in Kaya, Burkina Faso, had already been engaged in seed production since its official formation in 2002, and one individual member had even produced seed before that date. The group around this member, in the village of Zikiémé, has taken leadership in seed production activities until today. Similarly the organization Fuma Gaskiya in Niger had already started with seed production activities before it became partner of the CCRP project. They had started on their own initiative, and continued with support provided by the FAO, before joining the CCRP-funded project in 2009. The participatory variety evaluation trials had played an important role in establishing contacts and creating the motivation to engage in the seed project (see also next paragraph). 'Umbrella organizations' uniting several smaller/local farmer organizations, like AOPP in Mali and MOORIBEN in Niger, helped establish and implement the project activities at some locations. Most of the organizations mention they had previous contacts with scientists, either from ICRISAT, or their national research institutes, and thus became project partners in the seed project.

All participating farmer organizations are united by the motivation to improve the livelihood conditions of their members. Some see it as part of a broader approach that includes agricultural production, but also education, health, food security and income of the rural population. Others, more focused on agriculture, consider it an important means to help their members adapt to climate variability and change (changing rainfall patterns). Furthermore, getting access to seed of improved varieties is considered as a major step towards increasing productivity and income. Seed production in itself is seen as an interesting economic opportunity for the members. The entire approach to be part of an innovation process relating to variety development, seed quality and 'pro-poor' distribution activities is appreciated. Several respondents mentioned that they could see the opportunity to *"significantly"* improve agricultural production and livelihood conditions by producing seed of these varieties and making them available to farmers. One organization (AMSP, Burkina Faso) mentions particular interest in building up a functioning institutional structure for seed production in the region. Two farmer organizations consider seed production as their most important activity, whereas all others consider it as one of several important activities. Interestingly, those who consider it their most important activity are relatively small seed producers.

Figure 3 shows the amount of seed produced by the farmer organizations for the last five years. It has increased steadily, or even dynamically, for COOPROSEM, ULPC (both Mali), AMSP (Kaya, Burkina Faso), as well as MADDABEN in Falwel (Niger). It shows a little bit more variation or a slight decrease between 2012 and 2013 for UGCPA (Dédougou, Burkina Faso), as well as for the organizations HAREYBEN in Tera and Fuma Gaskiya in Serkinhoussa (both Niger).

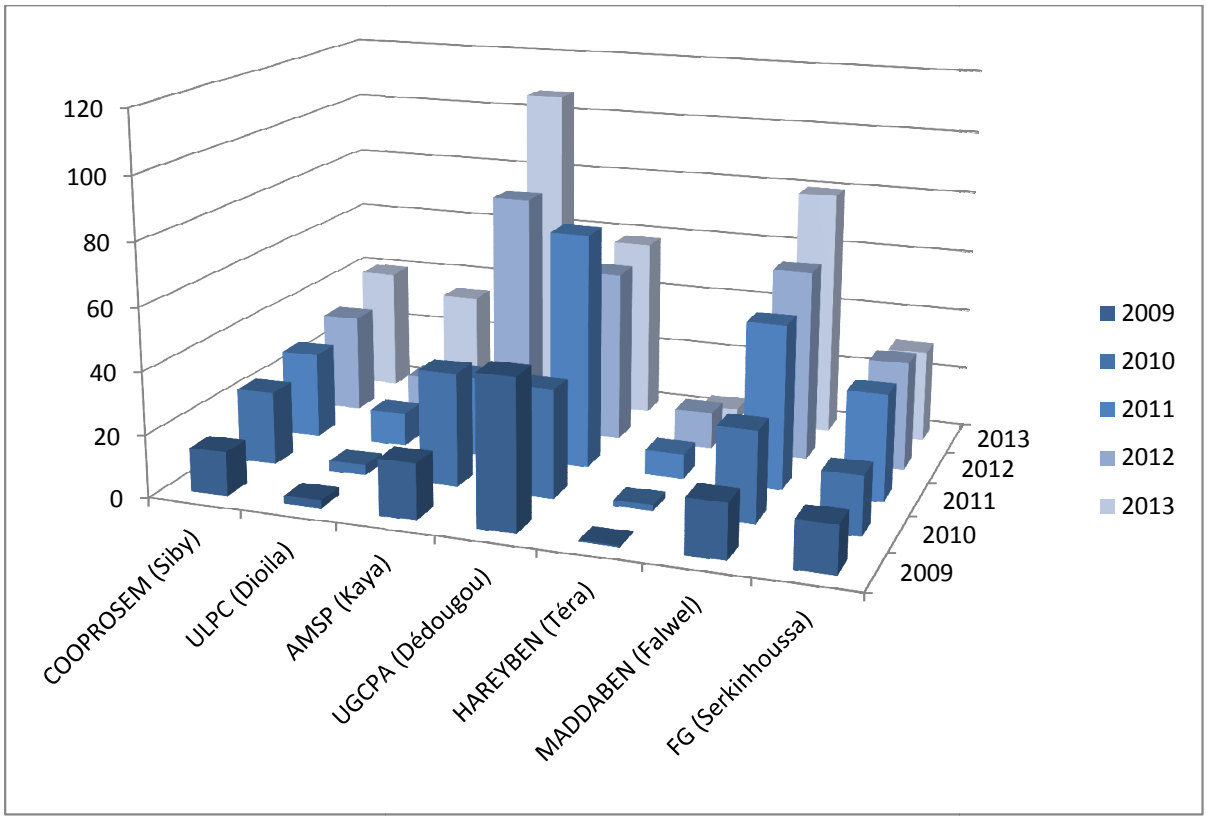

Figure 3: Seed produced [t] by different farmer organizations from 2009-2013; based on information from questionnaires (FG=Fuma Gaskiya)

There are relatively large seed producers, like UGCPA in Burkina Faso producing 55-75 t of sorghum seed annually; AMSP in Burkina Faso, where 107 t were produced in 2013; or MADDABEN in Niger, where 80 t of millet seed were produced in 2013. On the other hand, there are medium size seed producers (COOPROSEM; Fuma Gaskiya) and small producers, like HAREYBEN in Téra (Niger) with a maximum of 12 t millet seed produced in 2012.

Area-wise, the total amount of seed produced by these farmer organizations in 2013 is sufficient for sowing 16000 ha of sorghum and 11500 ha of pearl millet. This is a very rough estimate, based on sowing rates of 15 kg/ha for sorghum and 10 kg/ha for pearl millet; the amount of seed sown per area depends, *inter alia*, on field conditions and time of sowing.

Whereas some seed producers concentrate on sorghum or pearl millet seed, others produce and offer seed of various crops, including several varieties of these. Table 5 shows the number of varieties produced of each crop by the farmer organizations in 2013. These include own initiative or seed produced in cooperation with other projects. The number of varieties, and which varieties, varies from year to year. In Burkina Faso, difficulties to get source seed of farmer-preferred varieties were reported, a problem that limits the diversity of varieties produced (e.g. if compared to the situation in Mali). Some farmer groups additionally produced seed of hybrid parents or other breeder seed.

The number of seed producers was not collected from all organizations and varies from year to year. For AMSP in Burkina Faso, the organization that produced the largest amount of seed in 2013, the situation was described as follows: The sorghum seed production activities started with one person in one village producing seed on one ha of land in 2001. In the following years, 2-3 farmers of that same village produced seed, each farmer on one ha of land.

Table 5: Number of varieties per crop of which seed was produced by farmer organizations in 2013 (x= seed of this crop offered, but number of varieties not specified).

Crop	COOPROSEM	ULPC	AMSP	UGCPA	HAREYBEN	MADDABEN	Fuma Gaskiya
Pearl millet			x	1	2	3	5
Sorghum	13 (8 varieties, 5 hybrids)	24	5	3			2
Sesame			x				
Cowpea			x			2	3
Maize	x	2		3			
Groundnut	2						4
Rice	1						

After the CCRP-funded project started, the number of seed producers increased to about 15, of which 2 were women farmers. In the second phase of the project, the number of seed producers grew to ca. 30 (of which 2-3 women); they produced seed on ca. 80 ha of land. This means that not only the number of farmers increased, but also the area of land each farmer used for seed production. Additionally, millet seed was produced by 23 AMSP members, of which seven were women. However, the number of women seed producers dropped sharply in 2011 when a minimum production area of 3 ha was defined by new certification rules. Many women have limited access to land and thus tend to be excluded as a result of these official standards and rules. The number of seed producers per organization is thus generally not very high. For example, COOPROSEM in Siby, a 'medium size' organization with regard to seed production, had 21 seed producers in 2011.

All farmer organizations use multiple channels for marketing. These include seed sales to (1) individual farmers, (2) retailers, e.g. seed societies in Mali and private companies in Niger, (3) aid organizations and NGOs, (4) the state (in Burkina Faso). The relative importance of these marketing pathways is different for each organization. Whereas HAREYBEN in Téra (Niger) and UGCPA in Dédougou (Burkina Faso) focus on sales to individual farmers (most of which are members of the organization in the case of UGCPA), retailers are important clients for MADDABEN in Falwel (Niger), ULPC in Dioila (Mali) and COOPROSEM in Siby (Mali). Fuma Gaskiya in Serkinhoussa (Niger) sells the greatest share of the seed produced to aid organizations, whereas the state and NGOs are the most important clients for AMSP in Kaya (Burkina Faso).

There does not seem to be a general lack of demand, as the seed produced is also sold by the organizations in nearly all cases. However, it requires efforts, particularly to increase or stabilize the amount of seed sold to individual farmers.

The members of the farmer organizations have substantially improved their expertise and competencies for producing quality seed. They relate this directly to the trainings, technical advice, exchange visits and contacts with scientists that were facilitated by the project. The most important problems they face presently are: (1) provision of foundation seed; (2) growing needs for appropriate storage and processing facilities; (3) improved commercialization to ensure the sustainability of the activities; and (4)

"Commercialization is one of the major handicaps of our organization. We have large enterprises as counterparts that buy tons of seed on credit and do not pay even after one year. We do not know how to enforce our rights. Phone calls have remained useless."

(Member of a farmer organization in Mali)

problems concerning outstanding debits and delay in payment. However, not all problems are relevant to all farmer organizations.

Provisioning of foundation seed for a range of varieties seems to be particularly a problem in Burkina Faso. Unfortunately, the underlying reasons could not be explored by us, because the responsible person was not available at the time of the evaluation. That is why the cause of the problem remained unclear.With the increasing amount of seed produced, storage and processing facilities need to be expanded. This requires investment, as in the case of marketing activities. Problems concerning reliability of some market partners are potentially relevant to those organizations that sell larger amounts of seed to retailers. The farmer organization ULPC in Dioila (Mali), for instance, has not received payment from a large dealer (Mali Paysan) for more than a year, but there seem to be no clear mechanisms how payment of delivered goods can be effectively claimed or farmers lack experience with such situations.

ACCESS TO AND DEMAND FOR SEED

As mentioned before, it is not a tradition in the West African region to buy seed of staple food crops, such as sorghum and pearl millet. Besides seed provisioning from informal sources if own seed is scarce or of insufficient quality, seed purchase is mainly motivated by the farmers' interest in growing the new varieties.

That is why there is a tendency towards increased demand, but which is far from being stable and predictable. According to farmers (in Mali) who participated in our study, farmers take their decisions concerning variety choice shortly before sowing. In good rainfall years, that means early onset of the rainy season, farmers use local varieties and shift to improved varieties with shorter growing cycle if the onset of rainfall is delayed. This makes it difficult to calculate the demand for different varieties in advance and respond to it. Storage of larger stocks and over several years would be necessary to 'buffer' the variable demand depending on the climate variability in the target region.

In those villages where seed production takes place, in clusters of neighboring villages as well as surrounding areas farmers have gained access to seed of several improved varieties based on the project activities. This is particularly relevant for Niger, where only one relevant improved variety of pearl millet (HKP) used to be widely available before. The farmer cooperatives have developed and tested various strategies in order to increase demand and facilitate access: Regular market stalls, mobile seed shops, seed fairs, village shops, collaboration with intermediate and wholesale traders, or government agencies. Some of these activities are, however, still at an initial stage.

One specific approach to seed dissemination taken by the CCRP-funded project has been the promotion of mini-packets of new varieties of sorghum and pearl millet seeds. These mini-packets are 100 grams each, and cost between 50 and 100 FCFA, equivalent to 0.10-0.20 US-$, respectively. One mini-packet is sufficient for sowing two or three rows of 100 meters each.

It is known that poor farmers' access to new varieties is much facilitated by the 'mini-packet' approach: small packages sold locally at an affordable price are highly appreciated for testing and experimental purposes. The idea behind is to address the contextual constraints to the adoption of new improved varieties, which in Sahelian West Africa includes low rates of available cash and high opportunity cost for trying something new and unknown (Jones, 2014).

"We actually see an increased interest in new varieties, in the year following a bad season, because some farmers may not have harvested grain that is of good see quality (small grains due to drought), or their food stocks are low, and they want have a sorghum variety for an earlier harvest to break the hungry season earlier.

(A scientist)

In the case of open pollinating varieties of sorghum, the seed from the mini-packages can be multiplied, harvested and reused at least over several seasons. For pearl millet, being a highly cross-pollinating crop, it is more difficult to maintain varietal characteristics on-farm, depending on the size of field plots, and the proximity and flowering times of other varieties in neighboring fields. In general, farmers can maintain the seed over longer periods by performing selection.

The selling of mini-packages can involve high transaction costs for the farmer organizations selling them. That is why approaches such as mobile seed shops and seed fairs, as well as selling mini-packets in general village stores, still need to be fully assessed in order to learn about the potentials and limitations

Another attempt of facilitating access to improved varieties for poor farmers are seed distribution schemes run by governments and aid organizations. For instance, the Confédération Paysanne du Faso (CPF), an umbrella organization of several farmer organizations in Burkina Faso, demands the government to subsidize seed prices in order to facilitate poor farmers' access to seed of improved varieties. Such distribution schemes exist in the country and result in a very low seed price, like 2 US-$ for 15 kg of seed compared to approximately 10-30 US-$ for the same amount if purchased from a farmer organization.

Seed distributed via these government schemes (and similar activities of aid organizations) is not always recognized as high quality seed by those who receive it, particularly if the seed is distributed without labels and information on the variety. Parts of the seed may be consumed and not used for seed purpose, resulting in lost impact with regard to the breeding progress achieved. On the other hand, it has been reported that the sorghum variety 'Gnossiconi' has become widely known exactly because of this distribution pathway.

Because there may be limits to the economic feasibility of fulfilling seed requirements of poor farmers via value chains, the distribution of seed via government programs and/or aid agencies may be necessary as a complementary distribution pathway, based on the public interest to make seed of these varieties available to farmers who lack purchasing power to buy the seed regularly. However, the cooperation between the farmer organizations and the public or aid organizations needs to be better defined in the future, to avoid competition and loss of valuable seed.

With regard to access to information on varieties, the evaluation trials continue to play an important role. In Mali and Niger, activities with local radio stations helped raise awareness among general farmers on the availability of the new varieties, and possibilities to access the seed.

In her PhD thesis, Krystal Jones had looked deeper into the access decisions taken by various groups of farmers. She distinguished three important pathways for farmers to access seed of the varieties developed by ICRISAT's sorghum and pearl millet breeding program, together with the national research institutes: (1) conducting variety evaluation trials, for which seed is provided by the plant breeders, (2) purchasing mini-packets, and (3) getting seed via exchange or as a gift from the original buyers or testers. The results suggest that 'secondary' seed spread mentioned under (3) occurs at much broader scale than the other two pathways mentioned (Jones, 2014).

Farmers in her study were in general ambivalent about the change from a system of sharing and exchanging seed among socially 'close' people towards buying seed in shops and on markets. But the advantages were also clearly mentioned: (1) Saving time, because visiting friends or relatives may need time (for traveling), (2) more choice between varieties with different characteristics (3) more (or new) information. Farmers have to gain their own experience, for example concerning varieties losing key traits after several seasons, and also with the fact that accessing seed – even informally – has become more complex. Those farmers who invest time and money in producing seed of improved varieties, do not just 'give them away', as it was the rule earlier. The ways how people in need can access seed depends on many different factors, and their decision which path to follow are taken flexibly. There is no indication that women are excluded from certain access pathways, but a potential for exclusion exists based on an individual's social position, resources and skills (Jones, 2013).

Thus, the farmer organizations find themselves in a situation of transition: Demand for seed is increasing, but not at a very fast pace. The effects of the new seed legislation on 'secondary' seed spread as an important access pathway remains to be observed. The market segments they can reach with the mini-packet approach and via collaboration with state and aid organizations is not yet very well defined.

4.5 DEVELOPMENT IMPACTS

In this section, we summarize our results regarding the following criteria: Effectiveness, impact, efficiency and sustainability.

EFFECTIVENESS

Effectiveness is meant here as a measure of the extent to which a project attains its objectives. It describes to what degree the project's objectives were achieved, or are anticipated to be – and what factors are responsible for the achievement or failure.

The general objectives were framed as *"to contribute to the development of sustainable seed systems by strengthening farmers' seed commercialization initiatives in Niger, Burkina and Mali"* for the first phase, and *"to strengthen the dynamics of local social seed networks so as to improve local seed availability and thus increase the adoption of new sorghum and pearl millet varieties for improved food security and income"* for the second phase.

The project activities for reaching these objectives included participatory variety evaluation, activities relating to seed production and processing, and seed diffusion and marketing, as listed in BOX 2. Being a research project, a strong focus was on developing and testing appropriate methodologies for each activity. They further included capacity building to support organizational learning.

BOX 2: LIST OF PROJECT ACTIVITIES

- Establish variety evaluation trials in villages
- Participatory variety evaluation, including post-harvest and culinary traits
- Technical support provided by technical advisers employed by the farmer co-operatives
- Support to organizational learning (e.g. committees for fixing seed price)
- Information and training on seed certification
- Registration of producer groups at certification agencies
- Field inspection and seed harvest according to norms
- Processing and packaging in mini bags with labels
- Organization of field days, publicity, radio broadcasts
- Organization of seed fairs
- Offering seed at local shops or markets
- Offering seed via mobile seed shops
- Producing technical information sheets in local languages

These general objectives were achieved or are likely to be achieved – and to a high degree. Farmer-led seed commercialization initiatives exist in all three countries and produce certified seed, enough for sowing roughly 27500 ha of agricultural land. The seed commercialization initiatives thus successfully improved availability of seed and thereby facilitated variety adoption. Given the proven advantages of these varieties with regard to

yield, yield stability and quality, an impact on food security and income is likely to be achieved (see also next section on impact).

Activities relating to variety evaluation and technical aspects of seed production are highly effective. In this regard, the close connection between participatory variety evaluation, seed production and dissemination have contributed to the success. On the other hand, activities for post-harvest processing, certification and marketing still bear some more difficulties, at least for some organizations and in regard to seed marketing to individual farmers. A more precise definition and coordination of strategies, also in view of 'competing' initiatives of government programs and aid agencies, could support these activities.

In general, the success of the project highly depends on external factors and the cooperation between stakeholders operating at various levels. That is why the influencing factors and stakeholder relations should be fully conceptualized and targeted with appropriate activities in a possible third phase of the project.

IMPACT

Impact describes the positive and negative changes produced by a project. This involves the main effects resulting from the project activities on indicators that are usually pre-defined to cover various dimensions of impacts, including for example economic, social or ecological impacts.

In this study, we used a different approach that does not use pre-defined indicators. We used the Most Significant Change (MSC) technique (see section 3, p. 11) for documenting statements or 'stories' of impact from discussions with farmer groups. In a reflection following these discussions, the 'impact stories' were grouped into four different domains: (1) Impact relating to variety adoption and seed systems (2) Impact relating to productivity, income and nutrition (3) impact relating to knowledge, innovation and development capacities, and (4) (potential) negative impacts. We present farmer statements for all these domains along with additional information from interviews conducted with the farmer groups and other interview partners, e.g. researchers.

IMPACT RELATING TO VARIETY ADOPTION AND SEED SYSTEMS

Both farmer organizations and individual farmers, including women, conduct variety tests and participate in evaluations with high interest. They appreciate the participatory approach because they can observe variety performance and traits in the field. By comparing them over several years under variable climatic conditions, they can develop their own judgments regarding the strengths and weaknesses of different varieties.

Seed production has increased and continues to grow from year to year. This growth is based on growing numbers of farmer seed producers. The leaders of the organizations have recently started to reflect on an 'optimum' number of seed producers. Farmers with less land also participate in the seed production activities by cooperating with neighbors in order to meet the 3-5 ha minimum area required. Isolation of plots for seed production is not always easy to achieve, particularly in more densely populated areas. However, it is common to give seed of the same varieties to neighbors in order to reduce unwanted cross-pollination with other varieties.

"If people see the improved varieties growing well in the field, many want to try them."

"It is easier to get seed now – in the past we had to go from village to village, but now they are close."

"In the past, you had to search for seed of specific varieties in case of need – now we know the places where we can get it."

"You don't exchange seed of new varieties, you buy it."

An important impact is that it has become easier for farmers to access seed of improved varieties, and this in turn has an impact on variety adoption.

Farmers and farmer groups who participated in our study estimated that adoption and utilization of the new varieties was 25-50% in the villages where seed was produced, 5-15% in clusters of neighboring villages and 2-10% in general (countrywide). INRAN scientists estimated that adoption of improved pearl millet varieties in Niger (countrywide) had increased from 3-4% in 2004 to 10-12% in 2013.

IMPACT RELATING TO AGRICULTURAL PRODUCTIVITY, INCOME AND NUTRITION

The improved yields, particularly in sorghum, have 'saved' the crop from being replaced by maize and cotton crops. In some villages of Mali and Burkina Faso, farmers diversified their farms by replacing cotton with sorghum seed production. By using the improved varieties, the crop has become profitable again and yields are more stable according to the farmers. The improved varieties respond better to fertilizer, are more tolerant to variable rainfall conditions and more productive. Many of them are multifunctional in that they combine shorter duration, higher yields and better fodder quality for livestock. Altogether, these advantages result in better food security and income.

The fact that the number of farmers who wish to join the project activities is on the rise shows the high interest farmers have in the issue. Seed production is perceived as more lucrative than grain production and the knowledge gained (on varieties, seed storage etc.) helps farmers improve their own cereal production. The farmers report yield increases of 10-20% if improved varieties of sorghum and pearl millet are used, and of up to 50% (in that case from 800 kg/ha previously to 1200 kg/ha now) if combined with improved cultivation practices, such as fertilization and improved manual weed control. Improved yield and income have helped some farmers invest in animal traction, thus improving efficiency and reducing dependency on hired agricultural laborers.

For the men, the most significant change they associate with the project is improved productivity and income, as well as increased food security. As a result, they have improved the livelihood of their families by being able to invest more in the education of their children, in housing and buying more land. They are now able to pay timely for necessary expenses relating to health care, religious ceremonies and taxes (without taking loans) and can spend more money on clothes or mobile phones. The money they can spend also helps other villagers, like craftsmen and people providing services.

Women farmers highlight the improvements in the conditions of their lives, particularly relating to improved food and nutrition for themselves, their children and other family members. Improvements in nutrition do not only result from the new varieties they got to know, but also from the training courses they were able join. The additional income the women get from seed production or other activities that were started along with growing the new varieties (e.g. selling flour and other processed products) helps to fulfill modest needs of themselves and their children, to improve the meals and to more easily cover necessary expenses.

"Not only we harvest more and eat well, the animals also eat well. With the new sweet sorghum variety, the animals grow better and investing in livestock is a good choice now."

(A farmer of Kaya, Burkina Faso)

"We have produced so much that all the shops in the village are full… some bags are even stored in the health center of our village."

(A farmer of Kaya, Burkina Faso)

"I personally think that seed production is more profitable than grain production and gives us sufficient revenues to realize our lives. The only problem is that the seed does not give us income timely enough. We have to wait for months to get the certification and then again for selling, and the market is not reliable."

(Farmer of Magnabougou, Mali)

"The most significant and surprising change is that […] there are no agricultural workers any more in the villages – everybody works for his own family. This can be explained by more food and more money… The hope to harvest inspires us to invest in our own work. We invest in agricultural inputs, quality seed – not only of millet, but also of chickpea and groundnut… in order to increase our income, even without salary. Several households own harnessed teams now [animal traction]."

(A man from Falwel, Niger)

"A certain redistribution [of income] also occurs in the village because we can give more to the poor. The Zakat [dime] of the production we get is now being distributed to the poor. Earlier, we did not give because we did not dare to take the risk. We also give a share of the harvest to our women's braiders [tresseuses]. The increased income also helps to develop some other branches, such as masonry and tailoring…"

(A farmer from Téra, Niger)

"In our area, a significant change is that the land area for seed production is increasing. Even I, being a woman, started with 2 ha of seed production and I had rented the rest. But now I own 4 hectares and I expect buying more from my neighbors […]. The land price is quite high, and everybody now wants to have 5 hectares in one single plot […]."

(A woman from Maradi, Niger)

IMPACT RELATING TO KNOWLEDGE, INNOVATION AND DEVELOPMENT CAPACITY

The seed producers understand the certification procedures and necessary quality standards and are able to comply with them. The technical advisers are highly motivated and esteemed by the farmers, but field visits can be delayed in some cases as they tend to be overcharged with work. All farmers who participated in our study agreed that their technical knowledge, professional skills and production had increased while the number of fields/seed lots that were rejected because they did not meet quality requirements had decreased. The latter was related to support and training provided by the project.

The seed producers are well known in the surrounding villages for being advanced farmers with good harvests. They further enjoy a good reputation as being trustworthy people. They also regard themselves as 'experts' in agricultural production, and are being consulted in some cases even by government officials with regard to technical information, for example relating to the demonstration trials (information from a focus group discussion at Falwel, Niger).

Some farmers have started to produce seed of other crops, based on the technical knowledge they gained (e.g. maize, vegetables). Some are not only farmers, but also engage in selling seed and fertilizer. They are active members of their cooperative, give advice to other farmers or are members in official agricultural bodies.

Some men farmers stated that they had changed their view of agriculture and understood that it is an ambitious and professional work that requires knowledge and compliance with technical standards and norms. This change in attitude also concerns their children. The family members make a lot of effort today for getting information and improved seed, not only of sorghum and pearl millet, but also of other crops, mainly cowpea, groundnut and vegetables. Some farmers from Kaya in Burkina Faso even went to a city called Galmi in Niger to purchase onion seed there (information provided by a seed producer in Kaya, Burkina Faso). Women farmers also appreciate the knowledge and capacities gained with regard to technical knowledge on agriculture and their awareness of change in general. The most significant change, however, is for the women the mobility they gained through the project activities, which is a form of empowerment.

NEGATIVE IMPACTS

The farmers who participated in our study were not able to report on any substantial negative impacts of the project besides a general 'envy' that may occur if some people successfully participate in new activities and others not.

"Now I see the differences between different seed qualities. Earlier, I thought that we could sow any grains after the first good rainfall. And if the harvest was low, I thought it was due to the soil that has been exploited for so many thousands of years… Today, I know that poor seed quality is also one factor contributing to low yields. We were simply farmers without knowledge, and this ignorance is cause of our poverty…"

(A farmer of Dédougou, B.F.)

"With the pluviometers, we sow just in time after the second good rainfall. We have finished with sowing too early and resowing…"

(A farmer of Falwel, Niger)

"The training for change is a real trump card, because it helped us to diversify the meals. The enriched food helps us to better feed our children, and above all to recover those who are malnourished."

(A woman from Siby, Mali)

"Earlier our husbands did not let us leave the house without permission. But now, with the many trainings and exchange visits organized, the husbands do not try any more to impede us from leaving the village, we can go out and follow our various occupations."

(Women focus group at Falwel, Niger)

Researchers stated that impact may be lost where quality seed is being distributed to poor farmers without the necessary information, and used for food instead of sowing purpose. However, it is not known to what degree this really happens.

A potential negative impact stated by researchers is that growing new, highly productive varieties without adapting soil fertility management could result in a depletion of soil nutrients and decreasing productivity in the long run.

EFFICIENCY

Efficiency is an economic term measuring the outputs of a project in relation to the inputs. Looking at efficiency thus aims to make sure that the least costly resources possible are used in order to achieve the desired results. This generally requires comparing alternative approaches in order to see whether the most efficient process has been adopted.

Doing such an assessment based on economic data clearly went beyond the scope of our study, which was mainly based on qualitative information. Economic assessments are, however, available from other studies that focus on the breeding activities. *Ex ante* assessments of economic surplus achieved through breeding relies on a number of variables that can only be estimated. One important variable in economic assessments of breeding programs is successful seed delivery (M. Smale, personal communication). Thus, the approach taken by the project, combining farmer-managed variety evaluation and seed production, could be regarded as an important building block *that helps the breeding program* achieve its full impact. As mentioned, variety adoption and seed delivery have been important bottlenecks in the past.

An ongoing study conducted by Smale et al. (2014) focuses on the Guinea-race sorghum hybrids from ICRISAT's collaborative breeding program. For the expanded project lifetime, including the period 2000–2025 for cost streams and 2009-2025 for benefit streams, the present value of gross benefits of Guinea-race sorghum hybrids research and seed provision is estimated at over US$ 54 million in the target zones alone. The net long-term benefits are estimated at US$ 52 million. The long-term rate of return is projected at 36% per year with a benefit–cost ratio of 40:1. The benefit–cost ratio of 40:1 indicates that each dollar invested in the pilot project to develop Guinea-race sorghum hybrids in Mali generates 39 dollars of net benefits. That means evidence suggests highly cost-effective research on this particular pilot project – but depending on successful seed production and dissemination.

In view of the impacts described, the CCRP-funded seed production project appears highly efficient. Not only has the variety adoption progressed at a faster pace than in the past; the focus on facilitating experiential and contextualized learning on varieties and seed production seems to have a more general influence on farmers' decision-making regarding variety use and production improvement.

With a total funding of roughly 100 000-150 000 US-$ per year, distributed to a number or partners in three countries, it is a relatively small project, particularly if compared to previous efforts to build up formal seed supply systems in the region. For example, investment in formal seed supply was estimated to sum up to 45 million US-$ in Niger alone with very modest results regarding the contribution of formally produced seed to farmers' seed supply (Ndjeunga, 2002; Ndjeunga et al., 2006). Thus, the problem of the project studied here is definitely not waste of funds, but rather the opposite – insufficient funding.

The project does not cover the full cost of the activities included. This may be intended, in order to mobilize other resources. However, instead of mobilizing resources this funding practice could also lead to lack of support to the project, or to slow progress. In few cases, it was reported that additional funds could be acquired, for example for a seed storage facility. But this seems to be rather exception than routine. In some villages, local assistants ('animateurs') work on a voluntary basis, but there were some statements indicating that – not surprising – they work more efficiently where allowances are paid.

At ICRISAT, full cost covery is explicitly demanded by the funding requirements of the organization. Not responding to it may not be the best path to efficient cooperation in the longer term. Co-funding and building on synergies were applied to partly solve this problem, and in fact the project has profited from the linkages with other projects, such as the 'An Be Jigi' or the HOPE project, and another project working on improved cultivation and fertilization practices.

SUSTAINABILITY

Sustainability refers to social, ecological and economic aspects of project development that influence its chances to continue after funding has been reduced or withdrawn. For the CCRP funded seed project in West Africa, we see positive developments as well as open questions relating to all three aspects of sustainability mentioned.

Varieties have been successfully developed and tested that respond to farmers' needs and help increase productivity and diversification of farming systems under the variable and changing climatic conditions. Given the ecological, economic and social importance of farming in the target area, this alone is an important contribution to sustainability. On the other hand, it is an open question whether the higher yield levels of improved varieties do not require other changes in farming systems, particularly soil fertility management measures, to last. This issue is already being addressed by some other ongoing research activities, some of which also funded by the CCRP within the West Africa 'Community of Practice'.

The shift from traditional ways of provisioning towards regularly purchasing seed of improved varieties or hybrids raises questions with regard to the effects on traditional seed systems and food security of vulnerable groups. As long as informal pathways of accessing seed continue to exist and are not illegal, this may not become a major problem. However, promoting the emerging farmer-managed seed value chains could be considered as an activity that is embedded in a broader approach to Integrated Seed System Development, so that the seed value chains would be (purposely) connected to other measures, e.g. that guarantee access to seed for vulnerable groups. Government programs and aid organizations could be important partners in this regard.

Farmers have profited economically from the project activities, both in their roles as seed producers and as users. However, the demand for improved sorghum and pearl millet seed from individual farmers is still limited and most of the seed produced is sold to AGRA supported seed distribution companies, government agencies and NGOs. Furthermore, the distribution pathways of the government schemes and NGOs do not seem to be well coordinated with the emerging seed value chains, so that the same seed could be available from different sources at very different conditions. The farmer-managed seed production also depends on the availability of source seed provided. The responsibilities for decision-making on which amounts to produce of which varieties, and how this could be coordinated with (variable) demand, is an issue to be addressed in order to reduce risks for the farmer organizations.

The price at which seed is presently sold most probably does not cover the full production cost. It is therefore, important to put more focus on this issue and to raise awareness of the full cost of quality seed among producers and clients. Investment in storage and processing facilities is necessary but dependency on external factors (e.g. how the new seed legislation will be implemented and how it may affect the farmer seed initiatives in each country) increases risk of investments. Weak financial reserves consider a high risk for farmer organizations and individual producers; if payments do not come in on time, the organization's limited capacity to buffer such losses is easily exceeded.

The seed production activities appear to be well integrated in the overall activities of the farmer organizations. The trust of clients in the seed quality of farmer-produced seed is high. All our respondents further highlight and appreciate the improved relations between farmers, farmer organizations and research institutions. On the other hand, there are doubts whether the institutionalization of the collaboration is strong enough to sustain if

key persons leave their organization , and whether the participatory approach has been sufficiently understood, internalized and valued by other researchers (e.g. within ICRISAT as well as national research institutes).

In spite of the many and important positive attainments, we thus consider sustainability as the major challenge ahead for this project, and there are several issues that urgently need to be addressed in order not to lose the positive impact achieved so far.

4.6 CCRP CONTRIBUTIONS

A first and very important contribution of the CCRP program is that with its overall approach and funding strategy, it actively contributes to the development and implementation of research approaches that relate to current understandings of innovation and change processes. In order to reach impact 'on the ground', not only researchers need to gain new insights on the functioning of food and farming systems, but also those people who are acting in these systems. The common perspective of farming systems being mainly production systems that can be enhanced with innovative technologies is complemented by a different perspective focusing on them being human activity systems, in which goals, needs, values and capacities of people play a major role.

In this type of actor-oriented approach, 'participation' is not only needed to increase client-orientation and facilitate adoption of technologies, e.g. new varieties. Rather, it is based on the premise that changes in a 'real-world' situation can occur if the relevant actors collectively change their actions; in our case study, these would be all actors along the seed chain. In order to achieve such change, experiential learning, experimentation, as well as capacity building play an important role. 'Transformation knowledge' is collective knowledge that is needed to change from one situation to another, and it includes technological knowledge along with practical and organizational skills, and the resources and capacities that are required for a successful transformation (see for example Kaufmann et al., 2013).

„It is still not easy to find donors who understand that this is research."

(A scientist)

By facilitating exchange between different actors, the needs for adapting research and capacity building according to the needs for achieving the desired impacts can be defined and adjusted throughout the project lifetime. In this particular project, the technical advisors (*conseillers techniques*) have a very important role in this regard. They implement the project activities on the ground, facilitate field research and help documenting results in a systematic way. Thus, they enhance links and flow of information between farmers, farmer organizations and researchers.

Participants from all organizations involved in the evaluation stated that the capacity building helped them to develop their activities also beyond the project itself. Farmers in general appreciated the capacity building, training and support relating to technical aspects of seed production provided by the project. They valued highly that they have gained capacity to collaborate with 'officials', researchers and authorities, and that they were esteemed as being 'expert farmers' who serve as role model and guide to others.

How this actually influences their activities and ways of acting is, however, difficult to grasp. Examples mentioned were that some small producers, particularly women, formed groups to be able to continue seed production when the minimum area was set to 3 ha. Members of seed producer groups in Burkina Faso reflected jointly on how to best cover seed certification cost which occurs before getting any revenue from seed selling. Women in particular valued the 'training for change' they had participated in, and that the trainings had increased their mobility and freedom to take up own activities.

These examples show that people, individually or collectively, strive for solutions to challenges they meet, and the capacity of doing so is most likely not limited to a particular project activity. However, it can also not easily

be ascribed to a particular training they obtained. Rather, it could be considered a general empowerment gained through collective action and capacity building in the overall context of the project. Scientists who participated in our case study also valued the CCRP activities. It was stated that they had learned from the participatory approach and regard it as successful in view of breeding outcomes and variety diffusion. Some stated they had gained a lot of expertise in seed issues, which was previously not in their regard (e.g. as plant breeders. They had profited from capacity building and from the cooperation with ICRISAT and the farmer organizations. The 'fiches techniques' (technical brochures on seed production) were highlighted, as an important outcome, but the process of preparing them seems to have been important as well. They also appreciated that students are exposed to the collaborative approach in the field, which is otherwise not practiced at universities in the target region.

For IER in Mali, for example, it was stated that the project had helped improve the links between the national institutions and the rural population, as well as between IER and other similar institutes in neighboring countries. It was emphasized that this does not only includes formal 'contacts' at an institutional level, but also building trustful and reliable relations between the people involved, including the farmer organizations for example. The IER as an institution had gained credibility and reputation through the successful breeding and seed projects.

The CoP meetings represent a framework for regular exchange among the project partners. Scientists stated that participating in CoP meetings and exchange visits helped them gain new inspiration and broaden one's mind. Furthermore, it becomes easier to contact people one gets to know and this could facilitate cooperation in the future. However, only three participants per project for a CoP meeting are few compared to the number of people involved. As some research institutes and farmer organizations are involved in several CCRP-funded projects, it is sometimes possible that more people from one organization participate in the CoP meetings, which was seen as an advantage. Particularly scientists from INRAN, who appear to have hardly any funds for taking initiatives beyond 'business as usual' stated their gratitude for receiving funds for travelling to such meetings via the project. The time schedule of CoP meetings was, however, perceived as being very tight and demanding, and the monitoring and evaluation sessions somehow 'artificial' or 'intellectual'. It was suggested to complement CoP meetings with more exchange visits within projects with the aim to gain insights from assessing how activities are implemented practically in the various countries and localities.

Regarding the relations with other initiatives and projects, our insights may be limited but it is our impression that networking functions well for knowledge exchange on conferences and also for training and capacity building, but less for other fields of action, e.g. joint activities for seed marketing. Thus, cooperation with other organizations beyond the project partners remains occasional and selective rather than systematic.

5 DISCUSSION OF RESULTS AND LESSONS LEARNT

The first important result is that the project convincingly demonstrates that farmer-managed seed production is feasible, also beyond a very local scale, and that the availability of seed facilitates variety adoption. In that these varieties produce higher yields under the variable and often adverse agro-ecological conditions of the region, the farmer-managed seed production contributes to food security and improved income, as it was assumed in the 'theory of change'.

This success is rooted in a number of conditions. The farmer-managed seed production started from the involvement of the farmer organizations in the breeding program and their active role in implementing decentralized participatory variety evaluation trials. Therefore, the cooperation was already established and the members of the farmer organizations as well as other villagers had already gained knowledge and hands-on experience with the varieties. One of the first and important lessons to draw is thus that plant breeding, seed production and variety adoption depend on each other. Investment in seed production can only be successful if relevant varieties are developed, and farmers have had the possibility to gain contextual knowledge about

these varieties to take informed decisions on their adoption, and if the seed value chain is functioning in all its aspects.

The participatory approach thus allows for joint learning of farmers and scientists in a 'real world' situation: based on their varietal choice, farmers work on their own land, in their own fields and with the knowledge, values and resources they have. Scientists learn by deepening their understanding of the context and incorporating it in their scientific models, approaches and practical activities. Farmer organizations improve their skills for supporting and implementing emerging solutions and new options. Needs for capacity building are tied directly to the practical activities.

An important finding thus refers to the research design and methodology: Research seems to fulfill its function and role for stimulating innovation particularly if fully involved in an innovation process 'on the ground'. By doing so, the often complained 'implementation gap' is reduced and collaboration enhanced. Furthermore, the project relies on the state of knowledge available on innovation processes and seed system development, and has successfully incorporated this knowledge into the design of the activities.

By working in the same range of agro-ecological conditions and under relatively similar socio-cultural conditions across several countries, it becomes possible to compare and evaluate results for their broader relevance, to join forces and to capitalize jointly on technical as well as socioeconomic outcomes. The close relations with other projects of the MF, ICRISAT and national research institutes in the target area further contribute to joining forces and increasing impacts. The seed project is embedded in a number of other related projects in which the same research and farmer organizations are partners. This allows integration and developing deeper insights how the various projects and activities relate to each other, e.g. activities focusing on nutrition, variety development and soil fertility management.

Cooperating with (few) scientists in the CCRP funded projects can make a change for and enhance capacities of these scientists and their team colleagues. Organizational change of these large and complex organizations can probably not be expected from such project activities, as it would require that a reflection on strategies and coordinated action happens *within* these organizations, involving various management levels. Senior research and research management staff change their models of implementation depending on experience they make, or depending on what information is available to them. That is why it could be worthwhile to design exchange meetings that are particularly focused towards the strategic management of research institutes in the region..

Building a regional 'Community of Practice' that addresses the various challenges of improving farming systems and their nutritional outcomes corresponds with the farmers' holistic approach, in which efforts to improve in agricultural productivity are not divided into 'disciplines', and where farming is closely related to household needs, e.g. nutritional and cash requirements.

There are also some important multiplication effects at the local level. Some farmer organizations receive 2-3 visits per month from individuals or other organizations in search of information relating to seed production. The farmers report that the training courses received help them improve their farming practices in general, and to cooperate with 'officials' also for other topics or issues. The project activities have led to a change in awareness among the farmers concerning the value of seed, and its importance for improving their production: yield does not only depend on soil fertility and rainfall, but also on the seed used. The high visibility of the new varieties in the villages has effectively facilitated a multiplier effect, thus supporting adoption and outreach of the project

The project partners acknowledge that women should share in the project activities and play an important role in them. The institutional 'culture' and environment the project partners created through their joint activities could thus help contribute to more productive, diverse, equitable and nutrition-sensitive farming systems.

The perspective of the project has evolved as the researchers have learned more about women's changing roles concerning sorghum production, which was originally viewed as a 'men's crop'. It used to be grown main-

ly on the land managed by the head of the extended family; however, in some areas, women increasing plant sorghum on the individual fields allocated to them by the head, along with legumes traditionally planted by the women. The women use these plots to supplement the dietary and cash needs of themselves and their children. That is why these plots, though small in area compared to the total land used for sorghum production, can be of high importance for the nutrition of women and their young children – one of the most vulnerable groups for under- and malnutrition throughout West Africa. However, the women do not only grow sorghum for consumption; they are keen to sell parts of the harvest for cash. Rising sorghum prices have added to these incentives for women's engagement (see also Smale et al., 2014).

Insights into women's changing roles in sorghum production emerged from the participatory variety evaluation activities and have since then influenced various other activities, including for example selection criteria applied in the breeding program. The involvement of women in the seed project activities is also a result of this change in perspective.

Women participate in variety evaluation and capacity building relating to seed production with high interest. However, their possibilities to participate in and profit from the project activities are strongly related to their possibilities to access and control production assets (e.g. land, labor). As it is necessary to have a minimum access and control over resources to produce seed, this nearly automatically excludes women without access to land, and poor people with limited access to land and other relevant resources, from the benefits arising from seed production and marketing. However, the project has taken action to be inclusive at least for participation in variety evaluation, training and other activities. Group-based activities could help open up possibilities where individuals lack access to the necessary resources.

However, the improved technical knowledge also helps women to improve the cultivation of other crops that are commonly grown by them. Women farmers (and also men) are interested in expanding the seed production to other crops that are important for their cropping systems, mainly legumes, groundnut, sesame and vegetable seed. This step could be envisioned provided that suitable varieties are available and that they could be tested and evaluated b farmers, based on the experience gained for sorghum and pearl millet. The women were also highly interested in activities and capacity building relating to processing and marketing of food products such as flour, couscous or *degué* (a sort of millet couscous). In such activities, women could participate even without having access to land.

The new rule for certified seed production that the minimum area should be 3 ha has pushed out many women from the seed production, as can be clearly shown by records held by the framer organizations. It is thus an example how formal rules can have exclusionary effects and contribute to gender inequality with regard to women's and men's possibilities to seize emerging economic opportunities. A rule that was based on a minimum distance to other fields where different varieties are grown would have been less problematic than a rule defining a minimum plot size.

Agricultural research projects that result in similarly tangible results for farmers are very rare, and the project thus exemplarily shows how research can contribute to development outcomes. The basic conditions for the approach to be successful were found to be (1) active involvement of relevant stakeholders (2) a focus on tangible and relevant outcomes (e.g. yield, seed, food, income) and (3) effectively addressing important constraints (low yields, climate variability, poor soil fertility, low availability of cash etc.).

The major landmarks achieved so far in the project are thus the following: From participatory variety evaluation to production of certified seed, with a focus on the technical feasibility and complying to certification standards in the first phase; and a focus on improving the organizational capacities and the marketing and dissemination activities in the second phase.

For the marketing and dissemination activities, a number of challenges still need to be addressed. The real cost of sorghum and pearl millet seed production seems to be not fully known or calculable at present. The farmer

organizations have received training courses on management and book keeping, but it seems that price setting is so far not based on sufficiently clear criteria. During the visits of the evaluation team, technical aspects of seed production were given much more importance compared to marketing activities, even though the latter are seen as the major problem by many farmers.

Local seed marketing to individual farmers is still weakly developed for the majority of farmer organizations and will require increased efforts to fully establish it. It appears to be easier for those organizations who sell mainly to their own members, like UGCPA in Burkina Faso, and more difficult if a 'general market' is to be addressed. It is a problem for some farmer organizations that it takes a long time until their stock is sold and even longer until they receive the money.

Whereas the technical support appears to be very well developed, the support concerning organizational issues, finance and marketing is not fully satisfactory. The technical advisors are fully integrated and 'close' to the farmers and their organizations, but the same has not been achieved so far for support in other fields of action, e.g. marketing, financial and legal issues.

There is also a lack of coordination between some of the actors along the seed chain. In order to reduce risks for the farmer organizations, the critical junctures with other actors should be more clearly focused on. These are (1) availability of source seed, (2) seed certification, and (3) the coordination between their own marketing and distribution pathways, and those of government programs and NGOs.

„A good marketing strategy is based on knowing the varieties, appropriate packaging, timely distribution in close proximity to farmers, etc. We can expect from farmers that they adopt the new varieties only if we are able to master the whole system."

(Leader of a farmer organization)

The provision of source seed of preferred varieties was mentioned as a problem faced by farmer organizations mainly in Burkina Faso. Unfortunately, a key person at INERA was not available during the time of the evaluation. Based on information provided by the farmer organizations, it seems to be a mixture of difficulties in planning the demand, and availability of funds. Scientists from national research institutes in the other countries also mentioned that the maintenance and storage of breeder seed, as well as production of source seed is regarded as a weak point in the seed chain. Lack of resources and equipment, presently being compensated for through cooperation with and coordination by ICRISAT, are problems that need to be addressed.

Seed certification rules, procedures and cost can potentially be exclusionary, delay seed marketing and reduce the economic benefits. Even though it seems that seed certification 'worked' in most cases, farmers reported that certificates came in late in some cases, and that the cost is relatively high. As far as we understood, seed producers do not only have to pay a general fee, but also the per diems of the people who are in charge of seed certification. That is why the cost can be considerable, particularly for smaller seed lots. It could perhaps be suggested to certification services to reconsider the payment system in view of potential exclusionary or discriminating effects for small producers. However, this issue could also be addressed for the whole seed chain, e.g. in multi-stakeholder consultations (see below).

Furthermore, the seed distribution pathways that can be dealt with by the farmer organizations should be conceptualized within the framework of the Integrated Seed Sector Development (ISSD) approach. The parts covered by the farmer organizations and by government programs or aid organizations, respectively, need to be more clearly defined and their activities more effectively coordinated. Alternatives to the present distribution schemes, e.g. alternative payment via vouchers, should be explored. Also, the ways how beneficiaries of subsidized seed distribution schemes can access information on the varieties should be discussed. Potentially,

the cooperation between farmer organizations as seed producers, also distributing seed at a scale that is economically viable for them, could be effectively complemented through cooperation with the government agencies and aid organizations, with positive effects on the scale of distribution and poor farmers' access to seed.

The project is now at an important turning point, as it moves from the research stage towards broader implementation. That is why new needs and challenges will arise, and these should be clearly focused on: Where are gaps of knowledge and capacity, and how could they be filled? Which material resources need to be mobilized?

For example, the farmer organizations may need to find possibilities to build up reserve funds that help overcome delays in payment, and ways to claim their rights and strengthen their position in cases of payment defaults. The technical equipment for seed processing appears insufficient as a result of the growth of volume. It was not regarded to be a limiting factor initially, but is now perceived as an important bottleneck. In Dédougou (Burkina Faso), a facility with high flow capacity has been acquired with the help of a Canadian aid agency. In all other places the technical equipment lacks capacity and will need investment in order to further expand and professionalize the activities. The same applies for storage facilities: the limitations of capacity force farmer organizations to limit the number of seed producers and the amount of seed produced. The facilities are not always technically appropriate for seed storage in the longer term.

Typical constraints faced by farmers and farmer-led seed enterprises in developing countries, such as lack of material resources, lack of reliability of market partners, distance to government services and institutions, cannot be overcome by research and capacity building alone. The most important challenge to sustainability, however, is the very high degree of dependency on *external factors* that cannot presently be controlled by the project partners.

Conditions of seed markets, and their ability to function, are strongly shaped not only by the market partners, but by the political environment as well as institutional and administrative infrastructures that define the 'room to maneuver' for those who act in these markets. Government structures are weak in many West African countries, a fact that results in high complexity as well as lack of transparency and trust. Furthermore, the political actors seem to have focused quite strongly on the predominating rhetoric and approaches of private sector seed system development in recent years, rather than taking a more integrated view as suggested by the ISSD approach. Altogether, this results in a difficult environment for the emerging seed markets. The project has not focused on these issues and clearly reaches limits here.

The fact that the necessary administrative infrastructure for variety registration and seed quality issues has not yet been fully developed to implement the new seed legislation, and a situation of general political instability in parts of the region, potentially threaten the success of farmer-managed seed initiatives. In Niger, for example, the degree of coordination of the seed sector was found to be extremely weak, resulting in low trust between various groups of actors. The same problem also exists in the other countries, though probably less pronounced. Establishing a seed production and marketing chain for high quality certified seed can only be sustainable if a certain degree of coordination, trust and control can be guaranteed in a way that supports emerging seed marketing initiatives, rather than limiting their chances for success.

The new seed legislation, if not implemented alongside considerable improvements in institutional structures and coordination, will probably not help the situation. There is also a risk that once functioning seed value chains are established, other 'players' enter the market and compete with the farmer organizations for the more profitable share of the market. That is why it appears necessary to clearly define and address strengths and weaknesses of farmer-managed seed production (as summarized in Table 6) , and also to build a political vision for a demand-driven seed market in which farmer organizations are active 'players' and participate in the emerging value chains.

These external factors all play a very important role for the success of the project. That is why we consider sustainability as the weakest aspect of the project in spite of the success and positive outcomes achieved so

far. The risk of failure will remain high if the original focus on variety development and seed production is not expanded. Farmers could, in the worst of cases, abandon seed production in spite of the technical and organizational knowledge they have gained.

> *„What is needed is a political will in all West African countries that this farmer seed production as part of the seed system should make good progress."*
>
> *(A scientist)*

We understand that focusing on the technical feasibility of tying variety development to seed markets suggests itself for a project implemented by a breeding program and its partners. First, because such activities are close to their original mandate (developing varieties that are adopted by farmers); but also because it could be a strategy to develop such a project in spite of 'seed' being a highly politicized issue (see section 4.1, p. 17-18). However, in order to implement the approach on a broad scale and with probably less external support in the future, it appears crucial to take the external factors into account, and to actively build strategies that tend to reduce the external risks for the farmer organizations.

Thus, we see weaknesses of the project not in what was done or how it was done, but rather in those issues that were not or insufficiently addressed. These include the political and administrative 'environment', the coordination of some actors along the seed chain, and the lack of access to material resources needed to make the project more sustainable and secure its achievements.

6 RECOMMENDATIONS

Our main recommendation is that funding and support provided by the MF should not be withdrawn or reduced at this point of project development, but continued in order to strategically address the issues that currently threaten sustainability of the project in spite of its numerous and convincing achievements.

In a possible next phase, we see a need for the project to address the remaining challenges, but also to move beyond its original focus on research, breeding and seed production. For this purpose, new types of activities should be envisioned that target the development of the seed sector in a more holistic way.

The remaining challenges in the seed value chain can be addressed right away. The main focus of the project so far has been on developing methodologies and capacity building for successful implementation of farmer-managed seed production. In order to achieve significant change, knowledge and capacities are important, but need to be complemented in order to result in sustainable outcomes. The importance of increasing material resources (besides knowledge) should not be undervalued. Therefore, the capacity building should be strengthened particularly for post-harvest, management and financial issues (full cost accounting, pricing, marketing, networking etc.) and be accompanied by organizing support to investment, building up protection funds and other risk reducing instruments. This may require improved or more clearly defined strategic partnerships with other initiatives. Moreover, professionally made publicity, i.e. via radio broadcasts with 'important' people and farmers making a case for farmer-produced high quality seed could help stimulate and scale up demand, and improve the visibility of farmer organizations as providers of quality seed.

Coordination should be improved particularly for those connecting points in the seed value chain where activities of farmer organizations depend on other people's actions. These are (a) provision of source seed, (b) seed certification procedures, and (c) seed distribution activities of government agencies and aid organizations.

Prior to initiating activities that target the seed sector as a whole, we suggest conducting policy and stakeholder analyses. A policy analysis of the ECOWAS seed legislation and the national seed laws in all three countries (Mali, Niger and Burkina Faso) should focus on the coherence of the seed legislation with international commitments in order to identify entry points for a science-policy dialog.

Table 6: SWOT matrix summarizing Strengths, Weaknesses, Opportunities and Threats for the farmer-managed seed initiatives in Mali, Niger and Burkina Faso. Strengths and weaknesses relate to internal factors, whereas opportunities and threats describe external factors

Strengths	Weaknesses
• Varieties with preferred traits and superior yield under farmers' conditions are developed • Participatory variety evaluation trials help farmers understand differences between varieties and making informed choices on variety use • Farmer organizations know technical requirements and certification procedure and how to comply with them • Seed production is technically well established • Farmers trust in quality of seed produced by their local farmer organizations • Seed production is attractive for farmers, also economically • Stakeholders along the seed chain know each other and their respective responsibility • Farmer organizations focus on development of farming communities alongside profits from selling seed and are accountable to their members • 'Community of Practice' Approach has strengthened the ties and trust between project partners • Project partners share a vision for a seed system that serves farmers' needs and creates value in the farming sector	• Buying seed regularly from formal channels is not the rule for farmers in the region • Local seed marketing is still difficult due to moderate/slowly growing and fluctuating demand • Lack of coordination with seed distribution schemes of aid organizations and state agencies; information flow to end users is not well established for this distribution pathway • National research institutes lack own resources to maintain varieties and provide source seed of farmer-preferred varieties (may be to varying degree) • Government control institutions lack capacity and resources (e.g. timely delivery of seed certification approval not guaranteed, certification cost high for farmers) • Processing and storage facilities available to farmer organizations are insufficient and require investment if seed volume grows • Farmer organizations lack capacity with regard to commercialization, financial and legal issues • Financial reserve/liquidity of farmer organizations is limited (e.g. in case of delayed payment)
Opportunities	**Threats**
• Internationally, there is high interest in building more sustainable, equitable and resilient seed systems • Expertise on developing Integrated Seed Systems (ISSD) is available • Governments of West African countries have signed the CBD and ITPGRFA • Governments of West African countries are committed to the Right to Food • Harmonization of seed laws could facilitate regional cooperation if fully implemented	• New seed legislation is driven by commercial interests promoted by powerful 'players', instead of balancing diverging interests • Weakness or absence of functioning institutions for implementation of new seed law could cause uncertainty and intransparency • New seed legislation could limit legal 'spaces' for informal seed transactions (Farmers' Rights) • Conditions in the market (e.g. reliability of market partners, execution of law)are not generally favorable for the farmer organizations (e.g. in case of payment defaults) • Once the formal seed market is established, large commercial enterprises could compete with farmer organizations for profitable shares of the market

Possibly, the international agreements signed by the West African countries could provide such entry points. The work should also focus on the ongoing processes for building institutions and defining rules for their implementation. Furthermore, the policy analysis should also describe the possibilities for civil society actors (NGOs, farmer organizations) and researchers to participate in the process, and list the important steps and decisions that will be taken in the process. On this basis, the organizations involved in the project could develop a strategy for a policy-science and/or policy-civil society dialog (see below). Researchers and farmer organizations could also develop policy briefs or invite for consultation, or join consultations organized by strategic partners (see next paragraph).

Furthermore, a stakeholder analysis could be conducted in order to gain insights into power relations, resources and interests that may guide diverse actors' strategies and that may help build strategic alliances. Some of this knowledge will of course be present with individuals involved in the project, but has probably not been systematically compiled and analyzed. The German development Cooperation agency GIZ, for example, has developed a practice-oriented approach to stakeholder analysis consisting of ten 'building blocks' that can be applied independently. They include classical stakeholder analysis tools, such as mapping of power and interest groups, but also force field analysis, or the identification of 'veto players', without whose explicit consent the project cannot be successfully implemented (Zimmermann & Maennling, 2007).

Stakeholder dialog could take the form of national 'Cadres de Reflexion' (or multi-stakeholder platforms) that work jointly towards strengthening and coordinating the sector. Strategic planning workshops should be performed for each country, in which government agencies, other donors, organizations and projects are involved, in order to clearly define weaknesses and existing bottlenecks and identify joint actions to address them.

The ISSD framework could be very helpful in this regard, as it avoids heating up the political controversy by acknowledging that diverse interests exist and that activities driven by these diverging interests can lead to different types of (useful) contributions to seed system development. The framework could also be used to better understand the different priorities of the various project partners, particularly the farmer organizations that take a sort of intermediate position, as they share public interest with the breeding programs, but their possibilities to act are limited to activities that are economically viable for the organizations and their members.

The project should further address the need for a science-policy dialogue, for example in the form of written policy briefs and/or science-policy consultations that may also involve other stakeholders. Scenario analysis has been successfully applied as a tool for such dialogue in other projects; the tool could help stakeholders arrive at a shared vision of how the seed sector in their country should look like within 15-20 years from now, and which role government institutions, farmer organizations and other enterprises could play in it to arrive at more sustainable, equitable and resilient seed systems. Farmer organizations should take the opportunity to engage in civil society consultations that may be part of the political process, and jointly work out a strategy for it. In Burkina Faso, for instance, such consultations exist already (R. Kaboré, personal communication).

In a possible third phase of the project, the national research institutions should play a very active role. Variety registration, maintenance of breeder seed and source seed provision are important for effective and continuing transfer of innovations from breeding programs into practice. The existing obstacles should urgently be addressed and where possible removed. Research needs stated by participants in our evaluation were improving storability of (some) new sweet sorghum varieties, and testing varieties for their performance in other locations. However, instead of just expanding the project activities to other locations, we think that efforts should rather be directed towards institutionalizing the approach as far as possible. Furthermore, besides climate variability, soil fertility management seems to be a key issue throughout the region. The integrated approach taken by building a West Africa 'Community of Practice' is promising and should be continued.

BOX 3: SUMMARY OF RECOMMENDATIONS

- Seed value chain
  - Address remaining challenges in the seed value chain, particularly with regard to seed marketing and (financial) risk reduction
  - Improve coordination, particularly with regard to source seed provisioning, seed certification and complementary seed distribution channels to end users
    - Policy analysis
  - Assess ECOWAS seed legislation and national seed legislations with regard to their coherence with international commitments (CBD; ITPGRFA; Right to Food) and the legal space for seed provisioning on-farm and farmer-to-farmer seed transactions
  - Assess ongoing processes and possible entry points for science-policy dialog
- Stakeholder analysis
  - Conduct a stakeholder analysis in order to build strategic alliances
  - Organize multi-stakeholder dialog
  - Scenario analsysis for seed sector development?
- Integrated Seed Sector Development
  - Use the framework to (fully) conceptualize the project within ISSD, particularly the differences/complementarities between public and private sector interests and the role of the partner organizations and farmer-managed seed value chains within the framework
- Research organizations
  - Continue integrative approaches (breeding, variety evaluation, crop/soil fertility management
  - Institutionalize decentralized, farmer-managed/participatory variety evaluation
  - Resolve disharmonies in funding strategies/requirements by combining funds from various sources
- Farmer organizations
  - Engage in policy dialog, build strategic alliances
  - Reduce risks, e.g. financial risks
  - Identify possibilities to improve the material resource basis (e.g. investment in seed storage and processing facilities where necessary)
- McKnight Foundation
  - Continue funding and support to the project
  - Adapt Monitoring and Evaluation procedure in a way that it (better?) serves the people acting in the projects
  - Complement CoP meetings with exchange visits/learning from practical implementation

For ICRISAT the disharmony between its own funding requirements ('full cost recovery') and the MF's funding strategy is an obstacle. On the other hand, experience shows that ICRISAT needs qualified partners exactly for bridging the 'implementation gap'. For ICRISAT, as well as the national research institutes, a lot of reputation can be gained, and impact from breeding programs secured, if the delivery of seed is ensured in the longer term and in a sustainable manner. That is why we think it is a shared interest to jointly resolve the existing problems by effectively combining funds from different sources.

For the MF, we consider the overall approach developed in the CCRP in general and the West Africa 'Community of Practice' in particular as an important contribution for developing problem-oriented and transformative

research capacities. Based on participant's statements, a need for adjustments could be identified in the Monitoring and Evaluation (M&E) activities. However, only few respondents made critical remarks, and it is difficult for us to make any recommendations here, due to lack of insight how the M&E is actually applied. The focus of any possible adjustment should be on facilitating learning and reflection particularly for those people who are acting in the projects. It was suggested that CoP meetings could be complemented by exchange visits ('on-site'). Perhaps this could be a path to follow. In Box 3, we summarize our main recommendations.

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Anja Christinck (PhD) is an agricultural social scientist with specialization in communication and extension. She has worked on plant breeding, seed and agrobiodiversity issues for about 15 years, with a focus on developing and conceptualizing methodologies for communication and collaborative learning in research projects. She is author and editor of books and publications relating to plant breeding and agrobiodiversity management, particularly in relation to food and nutrition security and sustainable development.

Marthe Diarra, development sociologist and gender expert, studied at the Universities of Toulouse and Nancy in France (1978-1985). For the last 15 years, she has worked as a consultant and leader of project evaluation missions for Care international, the World Bank, IIED, Oxfam, as well as for Danish, Belgian and Swiss development cooperation agencies, in Niger, Mali, Burundi, Benin, Rwanda, Congo and other African countries. She is author of various publications relating to vulnerability, land rights, social change, gender and rural development issues.

Gottfried Horneber studied agronomy with at focus on crop production and farming systems in the tropics and subtropics. He has worked as a consultant for more than 15 years, and has gained expertise in participatory approaches, sustainable farming practices, as well as rural development and gender issues, also in relation with adaptation to climate change in Africa. He is associated consultant of FAKT Consult for Management, Training and Technologies, an organization relying on more than 25 years of experience relating to project evaluation and capacity building.

ANNEX

A. PERSONS AND ORGANIZATIONS VISITED, 1-16 FEBRUARY 2014

Date	Location	Person/Organization	Comment
Mali			
February 1	Bamako	• Gottfried Horneber	Arrival
February 2	Bamako	Eva Weltzien, ICRISAT • Marthe Diarra • Gottfried Horneber & Marthe Diarra • Melinda Smale, Researcher (Impact study)	Planning & interview Arrival Team building session Interview
February 3	Siby Bamako	• Mamadou Coulibaly, technical advisor AOPP • Farmer group of COOPROSEM (7 men, 1 woman) • Women association Njeleni (14 women) • Mamadou Coulibaly • Team • Eva Weltzien • 'Africa Rising' Meeting	Interview Focus group interview Focus group interview Continuation interview Team wrap-up Feedback Dinner with 'Africa Rising'
February 4	Dioila	• Daouda Traoré, president ULPC & Yalaly Traoré, field advisor ULPC • Team	Interview Visit to ULPC field activities Team session
February 5	Magnabougou Wacoro Dioila	• Farmer seed cooperative (13 men, 6 women) • Delegates of 3 seed cooperatives (10 men) • Yalali Traoré • Team	Interview Interview Continuation interview Team wrap-up
February 6	Bamako	• Mamourou Diourté, Abdoulaye Diallo, Abocar Omar Touré, Bocar Diallo (IER, Director and staff of sorghum breeding program) • Amadou Sidibé (IER, genetic resources responsible) • Eva Weltzien & Fred Rattunde (ICRISAT)	Interview Interview Interview
February 7		• Melinda Smale (Researcher)	Interview
		• Mamourou Sidibé (ICRISAT, field assistant)	Interview
		• Oumar Coumaré (AOPP, responsible for seed activities)	Interview

Date	Location	Person/Organization	Comment
		• Issa Coulibaly (AOPP, coordinator)	Interview
		• Harouna Sangaré (Malimark A2F (AGRA))	Interview
Burkina Faso			
	Ouagadougou	• Team	Arrival Summary of findings Mali Preparation of fieldwork Burkina Faso
February 8	Kaya Zikiémé Ouagadougou	• Roger Kaboré (AMSP, president) & delegates of 3 seed producer groups (12 men, 1 woman) • Roger Kaboré & 3 technical advisors of AMSP • Seed producer group (16 men, 7 women) • Team	Interview Visit to a seed shop Interview Interview Visit to storage facilities Back to Ouagadougou Team wrap-up
February 9	Ouagadougou Dédougou Ouagadougou	• Hamado Tapsoba, (McKnight Foundation, Regional Representative) • Nonyeza Bonzi (UGCPA, president), Adama Sidibé & Yehoun Romaric (UGCPA, technical advisors) • Yehoun Romaric • 2 technical advisors & 9 seed producers of UGCPA (9 men) • Nonyeza Bonzi (UGCPA, president) • Team	Interview Planning & interview Visit to UGCPA storage facilities Focus group interviews (separately for producers and advisors) Interview Team wrap-up
February 11	Ouagadougou	• Mr. Iliboundo (Chamber of Agriculture) • Abdoulaye Semde (National Seed Service) • Flavienne Ouandaogo & Shaka Adindji (National Farmer association) • Assita Ouédraogo (UNPS-B) • Team	Interview Interview Interview Interview Summary of findings Burkina Faso
Niger			
February 12	Niamey Sadoré	• Team • Dr. Fatondji (ICRISAT, Niamey)	Arrival Interview

Date	Location	Person/Organization	Comment
February 12 (cont.)		• Tahirou Boye & Hamadou Amadou (ICRISAT, field technicians)	Planning & interview
		• Tahirou Boye	Visit to field station
		• Tahirou Boye	Interview
	Niamey	• Matthias Banzhaf (Ministry of Agriculture, advisor)	Interview
		• Team	Planning for fieldwork
February 13	Niamey	• Delegates of farmer cooperative in Téra (Harey Bane/Mooriben, 2 men, 1 woman)	Interview
		• Delegates of farmer cooperative in Maradi (Fuma Gaskiya, 2 men, 1 woman)	Interview
		• Zobinou Zed Mawusi (Project advisor)	Interview
		• Amadou Moussa Abdulaye, (FUGPN-Mooriben, president) & Alhaji Saibou Angou (APPSN)	Interview
	Falwel[4]	• Union Madda Bane, farmer seed producer group (8 men, 2 women)	Focus group interview
February 14	Falwel	• Union Madda Bane (9 men, 2 women)	Visit to storage and compost facilities Continuation focus group discussion
	Dosso	• Abdou Habou (seed inspector)	Interview
	Niamey	• Salami Issoufou (INRAN, Coordinator of Seed Unit)	Interview
		• Ibrahim Diori (AINOMA, Technical Director) & Aichatou Nasser (Director general)	Interview (AINOMA is a private seed company)
		• Adam Efangal (Chamber of Agriculture)	Interview
	Niamey	• Team	Team exchange
February 15	Niamey	• François Thomas (National Seed Laboratory, Ministry of Agriculture)	Interview
		• Team	Assembling and screening results, working out conclusions and lessons learnt from fieldwork
February 16		• Gottfried Horneber • Marthe Diarra	Departure to Germany Back home

[4] Marthe Diarra went to Falwel and Dosso together with Tahirou Boye (ICRISAT); Gottfried Horneber stayed at Niamey and conducted interviews there.

B. SKYPE AND PERSONAL INTERVIEWS

Bettina Haussmann, February 6, 2014

Eva Weltzien-Rattunde, ICRISAT, January 30 and February 13, 2014

Kirsten vom Brocke, CIRAD, February 11, 2014

C. E-MAIL CORRESPONDENCE AND QUESTIONNAIRES

Dr. Abocar Touré, IER, Bamako, Mali

Mr. Ali Maman Aminou, Director, Fuma Gaskya, Niamey, Niger

Mr. Yacouba Tanda, agricultural extensionist, Farmer Union 'MADDABEN'/Mooriben, Falwel, Niger

Mr. Amadou Moussa Abdoulaye, Executive Secretary, Farmer Union 'mooriben', Niamey, Niger

Mr. Sidibé, Adama, sorghum estensionist, UGCPA, Dédougou, Burkina Faso

Mr. Roger Kaboré, agronomist, president and extensionist, AMSP, Kaya, Burkina Faso

Mr. Yalaly Traoré, cereal extensionist, ULPC, Dioila, Mali

COOPROSEM, admininstrative committee, Siby, Mali

HAREYBEN, extension group, Téra, Niger

D. DOCUMENTS USED FOR THE EVALUATION

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