Participatory plant breeding for sorghum in Burkina Faso

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I- The innovation story

In a context of diversified, risk averse family farming systems with low access to agricultural inputs, the "Participatory plant breeding for sorghum" innovation emerged in Burkina Faso in the late 1990s to address the limited impact of conventional plant breeding in terms of developing improved varieties to meet the real expectations of Burkinabé producers. The innovation system studied in this case is **the adaptation of participatory plant breeding methods associated with capacity building for the production of improved seed to meet the requirements and constraints of stakeholders in the sorghum sector in Burkina Faso**.

The innovation process considered here is based on the complementarity of two types of innovation:

- a **process innovation** related to adaptation through its implementation of participatory plant breeding methods including the production and distribution of seed;
- a **product innovation** such as the creation of new productive, well-adapted varieties and the production of high quality seed (certified seed).

The geographical scope of the innovation analysed includes two zones: the **Boucle du Mouhoun region**, especially Banwa, Kossi and Mouhoun provinces, and **Sanmatenga province** in the Centre-Nord region. These two regions represent two distinct agro-ecological zones, which are differentiated mainly by their average rainfall amounts and their agro-production systems. The Centre-Nord region is situated in the Sahelian climate zone (less than 600 mm of rain per year) and the production systems are mainly based on millet, sorghum and cowpea, along with small ruminant breeding. The Boucle du Mouhoun region is situated in the Northern-Sudanian zone (600-900 mm of rain per year) where production systems are more diversified and include cash crops such as cotton, maize and sesame.

The timescale considered for this study covers 20 years from 1995 to 2015. Three phases are nevertheless distinguished within this timescale: the start-up phase (1995-2001), the development phase with the localised implementation of the innovation (2002-2007) and the consolidation/extended implementation phase (2008-2015). The impact study focused more on the second phase during which the major multidisciplinary project "Sorghum agrobiodiversity" was conducted in three areas of intervention, including the two regions targeted by this study.

Central to the innovation process are three research organizations (INERA, CIRAD and ICRISAT) and two farmer organizations (FOs), UGCPA and AMSP. These five organizations are the key stakeholders as well as those most impacted by the innovation. The other stakeholders influencing the process are the different departments of the Ministry of Agriculture responsible for agricultural extension or organization and monitoring of seed production, donors and development structures (rural development projects and NGOs). Figure 1 below clarifies the stakeholders involved in the process for each of the three innovation phases.

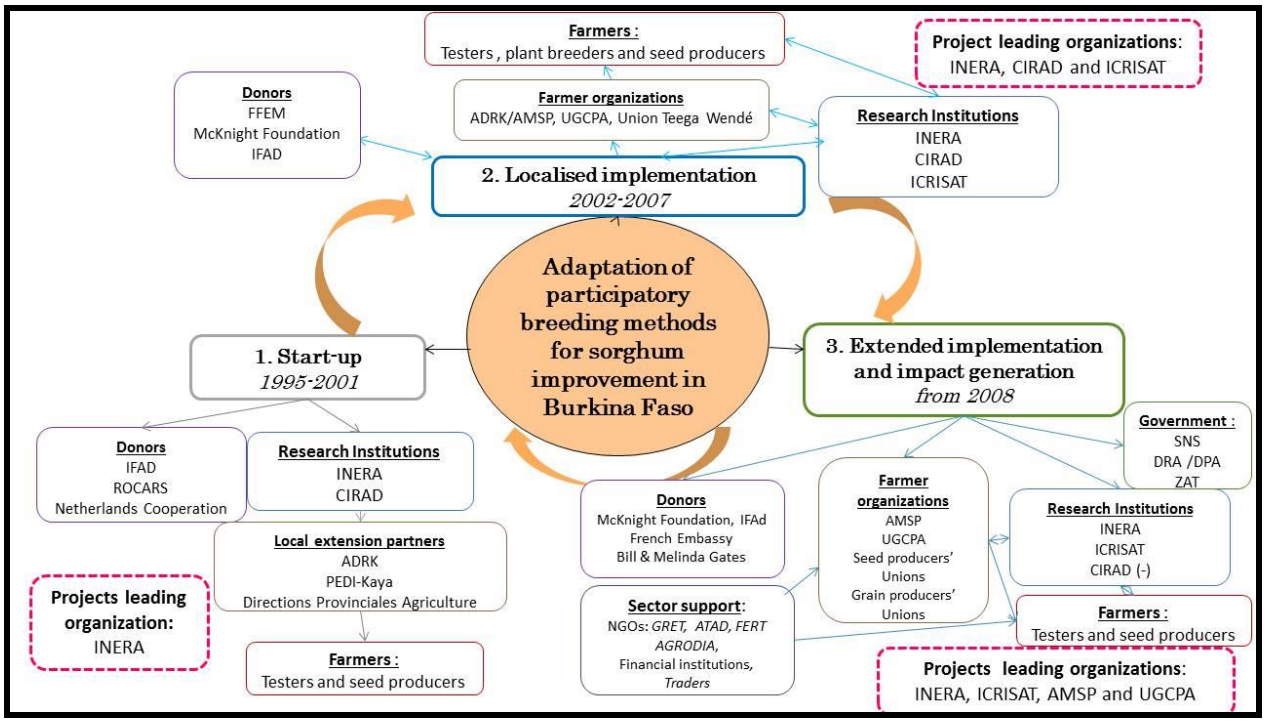

Figure 1 - Mapping of stakeholders in the participatory plant breeding for sorghum - Burkina Faso case following the three phases of the innovation process.

The construction of the innovation timeline was based on technical and evaluation reports for projects as well as on scientific publications. This bibliographical work was enhanced by exchanges with the case leaders. Finally, the timeline obtained was amended, supplemented and validated by the innovation stakeholders during the impact study fieldwork phase and the final validation workshop (Figure 2).

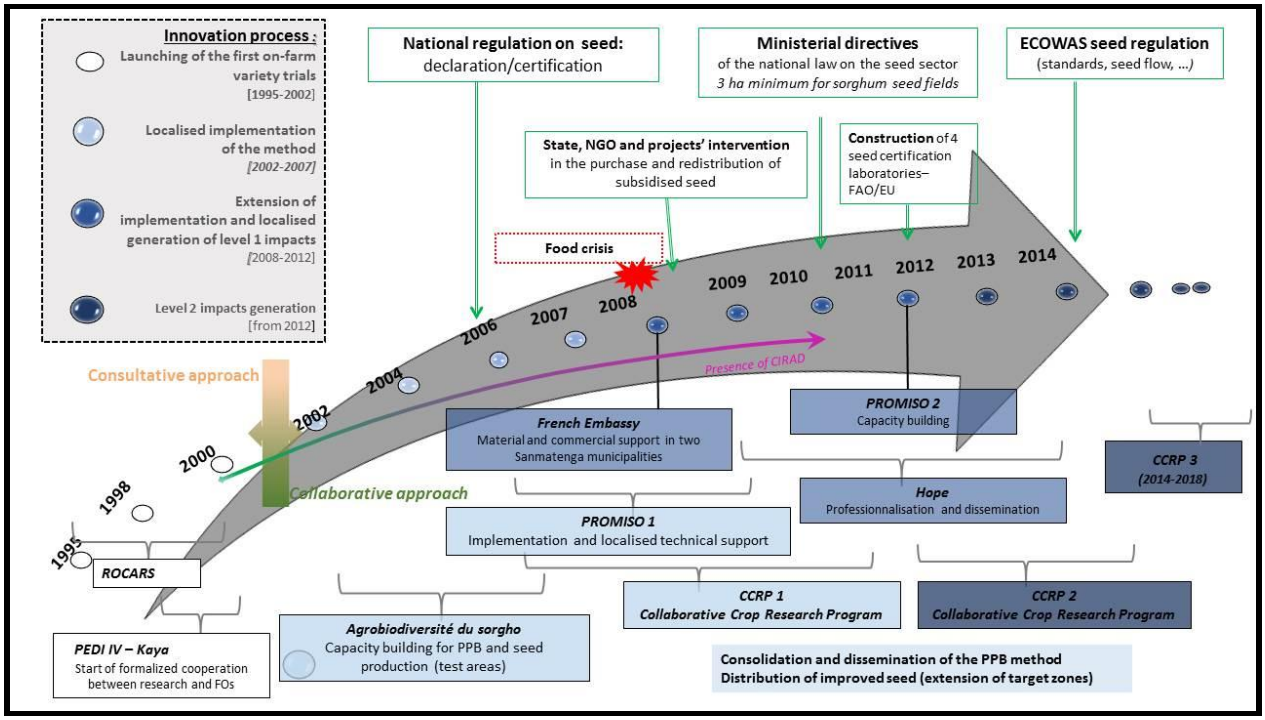

Figure 2 - Timeline of innovation with projects and external factors that influenced the innovation process

II - Lessons from an analysis of the impact pathway

The participatory workshops conducted in each region at the beginning of the study have given rise to 70 impact descriptors identified by the beneficiaries and institutional partners of this research. Some of these descriptors were completely unexpected for the case leaders and it was sometimes difficult to link them to a measurable impact. On this basis, the case team proposed around 30 potentially measurable impact indicators.

The development of the impact pathway was refined as the study progressed. This pathway was built from the identification of relationships between the IOOI components (Input-Output-Outcome-Impact) established and confirmed by the field study, but also by feedback from case leaders, from the methodological group and finally from partners during the validation workshop. The detailed impact pathway showed below (Figure 3) is the seventh version produced.

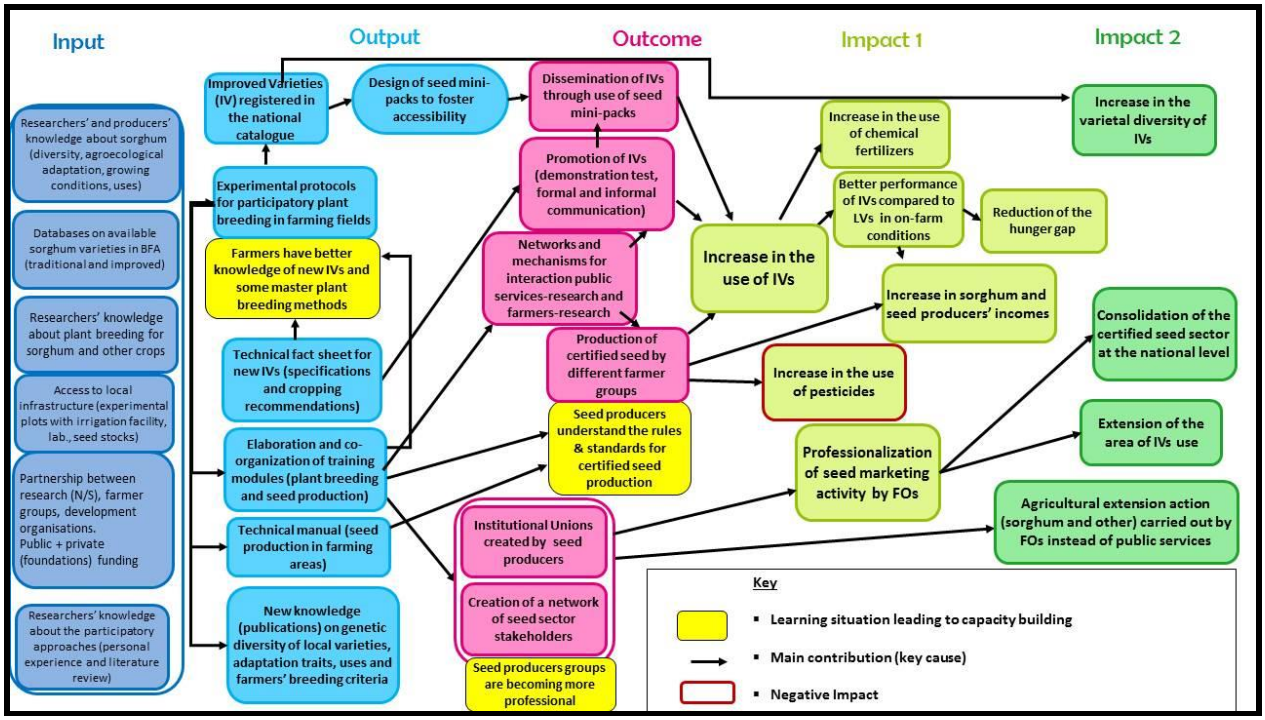

Figure 3 - The impact pathway

The three major outputs of this research were: 1) the new improved varieties (IVs) of sorghum resulting from the PPB approach; 2) the development of seed mini-packs concept making improved seed accessible to small producers; and 3) the new skills acquired by the farmer groups. The mobilisation of these outputs has been an element of their development. It has been driven by farmer groups with support from research. It has structured the existence of what we call the key outcomes, which are as follows: 1) networks and mechanisms for interaction between research and public support services (extension, seed certification, etc.), and between research and farmers (sorghum producers, seed producers); 2) the strengthening of capacities for variety testing and plant breeding and for the production of certified seed and its marketing according to new mechanisms; and 3) the establishment of decentralised certified seed production.

One of the salient level 1 impacts identified by the study is the spectacular increase in the use of IVs in the project's intervention areas, whose greater performance in comparison with traditional varieties helps to improve food security (fewer hunger gap problems) and to increase small producers' incomes.

Sorghum seed production activity has also generated a key impact in terms of increasing income for farmers who have become seed producers. Finally, these research projects have also contributed significantly to professionalising producers' Unions in the intervention sites for their certified seed production and marketing activities for several crops. Negative impacts have also been identified, such as an increase in the use of insecticide products for seed storing and risks of a reduction in varietal diversity in some villages covered by the projects.

Among the level 2 impacts, the contribution of the innovation to strengthening the formal seed sector at the national (or regional) level is a key impact. In addition, the validation workshop confirmed that the innovation has also significantly influenced certain guidelines for national and regional seed legislation.

In this innovation process, some elements have played a key role in the production of impacts: the Sorghum Agrobiodiversity project, which was the starting point for the innovation development phase; the continuity and coherence of the projects that followed it from 2006 onwards; the trust of certain donors in the long term (in particular the McKnight Foundation); the effective long-term cooperation between the three research organisations involved; and the stability and vision of the two partner farmers' organisations.

The study also showed that the initial research activity on participatory plant breeding for sorghum has structured a more complex "capacity building" process identified in the outcomes (indirect effect). A core change of the innovation was to enable producers to appropriate the basic knowledge and information needed to make varietal choices according to the different local constraints of agrosystems, to the social conditions of production or to food uses of sorghum. A vital tool for the increasing use of new IVs was the implementation of decentralised seed production, which in this context became an integral part of the innovation process.

The experimental impact analysis method tested here explored and highlighted the complexity and the multi-dimensional, multi-stakeholder nature of the processes structuring this technological innovation and its impacts on development. It has helped to better explain the role of research as a key player in the strengthening of individual and collective capacities to innovate.

III – Measurement of impacts

III - 1 Measurement of indicators by type of impact

The results of measurements of level 1 and 2 impacts of the innovation process here studied are summarised in tables 1 and 2 below.

Summary of the impact measurement method

The impact indicators were measured by means of individual interviews and focus groups with direct beneficiaries (sorghum producers, seed producers, inputs sellers, etc.) and indirect beneficiaries (for example sorghum processors) of the innovation. This measurement also relied heavily on secondary data from research, especially a study on the adoption of improved sorghum varieties conducted in 2013, and statistics provided by INERA and different departments of Ministry of Agriculture.

Evaluating the accuracy of measurements

One important limitation of the participatory methodology applied and of the means mobilised concerns the measurement of indicators related to the increase in income for beneficiaries of the project. In our study, this measurement was only qualitative and based on the perceptions of the people interviewed.

III - 2 - Ranking of impacts

Efforts were made to rank impacts in a participatory manner during the initial participatory workshops, but the case team subsequently decided that this was not a priority for the impact measurement study.

Table 1: List of impacts, indicators and their measurements for level 1 impacts

Impact	Indicators selected	Impact measurements
Increase in use of improved varieties	Change in number of producers purchasing certified seed % of areas sown with IVs in villages covered by PPB programmes % of areas sown with IVs in neighbouring villages	x 25 between 2005 and 2010 for UGCPA producers 70.5% compared to 3 to 5% for whole country 20% compared to 3 to 5% for whole country
Production of certified seed by different producer groups	Change in quantities of certified seed	AMSP: x 6 between 2008 and 2012 UGCPA: x 1.8 between 2008 and 2012
Higher efficiency of IVs compared to LVs	Yield difference between IVs and LVs Earliness of IVs compared to LVs Striga resistance of IVs compared to LVs	Yield gains: +7% to +30% 100% of producers questioned confirm that IVs ripen earlier Only producers' opinions, not confirmed
Increase in income for sorghum and seed producers	Cereal producers' perception of increase in their income linked to surplus sales Seed producers' perception of increase in their income linked to IV seed production	50% of producers from site villages indicate an increase in surplus production for sale thanks to IVs Consensus among people interviewed that seed production activities are lucrative
Professionalisation of seed production and marketing activities by FOs and increase in availability of high quality seed	Change in quantities of sorghum seed redistributed by state programmes (biggest purchaser of seed produced by FOs) Change in strategy of producers' unions to be less dependent on state seed procurement Change in units of seed most commonly purchased by producers	x 20 between 2010 and 2013 Description of strategies applied by UGCPA and two AMSP unions Increase in minimum and average seed units purchased by producers
Reduction in hunger gap	Producers' perception of a reduction in the duration and/or intensity of the hunger gap	100% of producers interviewed in non-site villages say that the food situation has improved with the use of IVs 43% of producers from site villages say that the hunger gap has disappeared
Increase in chemical fertilizer use	Change in chemical input purchases	50% of producers from site villages say that they use a higher quantity of chemical inputs for the production of IVs, but only 20% of producers from non-site villages
Increase in use of pesticides	Change in insecticide treatments used for improved seed storage	UGCPA officials confirm the use of insecticide products to treat stores and close to seed backs

Table 2: List of impacts, indicators and their measurements for level 2 impacts

Consolidated impacts	Indicators	Impact measurements
Increase in sorghum varietal diversity	Number of IVs produced from traditional lost or abandoned varieties Number of varieties from PPB entered in the national catalogue in 2014	2 varieties: FLAGNON and GNOSSICONI 27 sorghum varieties entered in national catalogue, 8 of which from PPB programmes
Extension of area of use for improved varieties	Destination regions of sales of foundation seed by INERA-Saria Sales of certified seed in neighbouring countries Seed sales network of input wholesalers' association	In 2014, IVs from PPB were used in at least 11 regions and 17 provinces in the country UGCPA sells certified Gnossiconi seed to a FO in the Tominian zone in Mali (UACT) The AGRODIA network distributes certified sorghum seed in all of the country's provinces (even the far north of the country)
Consolidation and structuring of certified seed sector at the national level	Change in national production of certified sorghum seed Change in production of foundation seed Change in proportion of improved sorghum seed in total cereal seed distributed by the state Change in area dedicated to sorghum seed production Change in number of seed training courses provided by SNS, INERA and CIRAD since 2001	From 26.3 t in 2001 to 2 933 t in 2014: multiplier > 100 From 4.7 t in 2001 to 33.5 t in 2014: multiplier =7 From 1% in 2010 to 19% in 2013: multiplier = 19 Data projections only: 5 150 ha in 2015 to 7 832 ha in 2018: multiplier =1.5 At least five training courses conducted between 2003 and 2008; the number of training courses conducted by INERA after 2008 can be found in annual reports
Increase in income or activity for sorghum processors	Processors' perception of increase in their activity thanks to IVs	Non-measurable impact as processors interviewed (especially dolo producers) know very little about IVs and cannot answer this question
Agricultural extension action (sorghum and others) conducted by FOs rather than state services in areas of intervention	Change in approach and stakeholders involved in agricultural extension	The surveys showed that research actions conducted by FOs, NGOs and research have modified agricultural extension methods in the areas and villages of FO intervention. State services have insufficient means and human resources. Consequently, FOs/NGOs and their members carry out a significant part of this extension work.
Effect on seed legislation	Influence of producers and FO officials involved in sorghum PPB on national and regional seed legislation	Several producers who took part in the sorghum PPB programmes contributed to drafting the 2006 seed regulation as representatives of seed producers' unions. These same people influenced the conditions for applying the rule of 3 ha as the minimum area for sorghum seed fields. The ECOWAS seed regulation was significantly influenced by Burkina Faso legislation.