Summary of ex-post case study

Hulling machine for fonio in West Africa

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I - The innovation story

The innovation presented here involves the development and dissemination of machinery for hulling and whitening fonio (Digitaria exilis). The geographical perimeter of the study covers mainly Mali where the innovation process started, as well as Burkina Faso where the innovation is also spreading. Fonio is considered the most ancient of traditional cereals indigenous to West Africa. Its production area runs from Senegal to Lake Chad, though its main production zone is in Guinea where fonio is one of the staple foods for communities in the mountainous regions of Fouta Djallon. Fonio is also found in Mali, Burkina Faso, Ivory Coast, Nigeria, Benin, Togo and Niger.

In the 1980s, fonio was little known outside its areas of cultivation where it was consumed only by producers. In most producing regions at the time, fonio cultivation was sharply falling with respect to other crops. Moreover, the cereal was completely neglected by research, as well as by agricultural development projects. The last studies dated from the 1950s when the famous French agronomist Roland Portères had written a monograph on this small cereal that was then not well reputed and referred to as the "leper on African soil".

Due, in particular, to the small size of fonio grains (around 1.8mm long and 0.9mm wide), hulling and whitening fonio are laborious operations that are traditionally undertaken by women using mortar and pestles made of wood. These operations are considered particularly onerous by women and at a rate of 1 to 2 kg/h take a lot of time. To obtain a high-quality product, impurities such as sand must be eliminated through multiple washes, which renders preparation long and fastidious. On top of modest yields (750 kg/ha), the additional work linked to post-harvest operations means that the crop is not very popular with producers and also that fonio sells at a higher price than other cereals.

![Figure 1 - Timeline](image-url)
At the end of the 1980s and the beginning of the 1990s, the PROCELOS programme (Regional programme for the promotion of local cereals in the Sahel) launched by CILSS (Permanent Interstate Committee for Drought Control in the Sahel) contributed significantly to promoting the consumption of local cereals in urban areas in the Sahel.

It was in 1993 that managers of small cereal processing businesses in Mali and Burkina Faso presented the difficulties they encountered in their fonio processing activities to Cirad researchers. They insisted that according to them, the only way to avoid the decline of this small traditional cereal was to find a way to mechanize hulling and whitening. In 1994 researchers undertook the first tests of mechanical hulling of fonio using a prototype millet and sorghum huller (DMS 500) that had been developed by Cirad. The initial results were not very convincing.

From 1999 to 2001, Cirad coordinated a project entitled "Improving post-harvest technologies for fonio" funded by the CFC (Common Fund for Commodities) and supervised by the FAO. This regional project was implemented in collaboration with research partners from the global South: the Guinean institute for agronomical research, IRAG, the Rural Economy Institute/Laboratory for Food Technology, IER/LTA in Mali, and the Institute of Research in Applied Sciences and Technology (IRSAT) in Burkina Faso. It is through this initiative that a machine for hulling and whitening fonio was designed and developed. The hulling machine was baptized "GMBF" as a reference to the cooperation between research institutes of the four countries that had participated in the project: Guinea, Mali, Burkina Faso and France.

The first phase of the project, from 1999 to 2001, consisted in testing different principles and hulling equipment that existed so as to check their performance for fonio. Through this phase the Engelberg principle, which is used in hulling rice, was retained as useful. The researchers, working with a few potential women users, then developed a "functional design brief" setting out the performances to be attained. This involved setting certain parameters, such as the speed of hulling-whitening (60 to 100 kg/h), the yield after processing (between 60 and 65%), and the rate of residual unhulled grains after machine processing (<0.5%). Using the "Engelberg" rice huller as inspiration, a specific hulling machine was designed for fonio processing. In the early 2000s, a first prototype was produced and tested at Cirad in Montpellier to validate the principle of hulling and draft up plans with the goal of setting up local production in Mali.

The rest of the innovation process was based on a multi-stakeholder partnership involving the research institutions, CIRAD and IER, and private sector stakeholders in Mali. Thus, the equipment manufacturer, IMAF, in Bamako took part in producing various prototypes which were tested in real-life settings in fonio processing businesses and then modified in the workshops of the manufacturer with the help of the researchers. A restricted group of four Malian women processors took part in the various tests. As future users of the machine, their participation allowed for the validation of technical choices and for better adjustment of design specifications to the needs of fonio processors.

At the end of the project, the machine was set up in the premises of the IER/LTA laboratory in Bamako to be used for service provision, as well as for training the numerous processors present in Bamako. These activities were very important in getting word out about the hulling machine in Mali.

The manufacturer IMAF, who is a key player in socio-technical network in Mali, received training and support through research during the production of the various prototypes. IMAF worked with the researchers from the very beginning of the project until the production of the final commercial version of GMBF huller in 2003. The firm has now sold more than 150 hullers mainly in Mali, but also exports machines to Burkina Faso (about 40), as well as to the whole sub-region (Benin, Niger, Nigeria, Senegal, etc.) In 2003, the firm SIPS created by a former IMAF employee also started producing fonio hullers, and after this, yet another huller manufacturer set up in San in the Segou region.

It was only much later that development organizations got involved, playing a very important role in promoting and disseminating the innovation. In Mali, from the 2010s, NGOs (IRD-US) and some development programmes starting subsidizing or encouraging the purchase of GMBF hullers by urban and rural processors. Only a few processors, mainly in Bamako, purchase the hullers with their own funds. Some fonio buyers, however, purchase the hullers and the offer hulling services to fonio processors. The IER laboratory has thus stopped providing this service, leaving it up to private operators. The sheller dissemination area is expanding, particularly in neighboring Burkina Faso.
II - Lessons from analysing the impact pathway
The impact pathway is a tool for visualizing the innovation process and the effects that it has. It is a type of representation that comes from the larger family of logical models, such as the logical framework, inspired by theories of change, or more specifically, theories of programme.

Figure 3 - The impact pathway
This impact pathway has been mainly built from feedback from stakeholders. It highlights the key points in the dissemination of the huller, as well as the chain of causal links and the different categories of stakeholders involved and beneficiaries.

Building this image of reality with the different stakeholders (researchers, manufacturers, processors, NGOs, etc.) enabled the identification of resources mobilized through research or inputs of widely varying nature: knowledge, financial and material resources, relational resources, etc. Likewise, the "objects" produced, or the output from research, were not limited just to the huller (the invention) but also included work methods (co-design), intermediate objects (plans, technical briefs), training tools and new knowledge.

A group of stakeholders composed of researchers from Cirad and IER, manufacturers and experimental processors made up the first circle who were direct stakeholders in the co-design of the machine, and later directly involved in the ownership of the outputs (outcomes) to then be impacted by the innovation. Thus, for the processors in this first circle, the acquisition and utilisation of the huller in their processing units enabled them to increase their incomes by increasing the quantities sold, and this in part through increasing the production capacity of their business and in part through improving the quality of fonio hulled mechanically (better accepted by consumers). Some processors also increased their income by offering services to other businesses without hullers. The manufacturer IMAF, who had interacted with researchers and processors saw its capacities strengthened through the various learning situations that arose during the co-design process. The production and the sale of the huller allowed IMAF to increase its sales revenues and its reputation on that national market in the agro-food machinery sector.

III - Measuring impact

III-1 Indicators by type of impact

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Description of impact</th>
<th>Level of impact</th>
<th>Outcome(s) that helped produce the impact</th>
<th>When did the impact arise</th>
<th>Stakeholders impacted</th>
<th>Indicators for quantifying and qualifying the impact</th>
<th>Principal source used to identify the impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased income for processors</td>
<td>The income of processors who use the huller increase</td>
<td>1 and 2</td>
<td>Use of the GMBF huller by processors</td>
<td>From project end - 2004</td>
<td>Producers</td>
<td>Quantities produced</td>
<td>Interviews</td>
</tr>
<tr>
<td>Job creation</td>
<td>The additional income made by different stakeholders enables them to offer jobs, especially on the part of urban processors</td>
<td>1 and 2</td>
<td>Use of the GMBF huller by processors and service providers</td>
<td>From project end - 2004</td>
<td>Urban employees (male/female)</td>
<td>Growth in numbers</td>
<td>Interviews</td>
</tr>
<tr>
<td>Reduction in the demanding nature of work for women</td>
<td>Rural pounders have less fonio to pound by hand, it’s less tedious (health, difficulty)</td>
<td>2</td>
<td>Use of the GMBF huller by processors and service providers</td>
<td>Difficult to say, end of 2000s, beginning of 2010s</td>
<td>Rural pounders (or rural processors)</td>
<td>Qualitative element - women’s opinions</td>
<td>Participatory workshop</td>
</tr>
<tr>
<td>Increased surface area cultivated</td>
<td>Overall demand for fonio is increasing which has led to an increase in the quantity of fonio grown</td>
<td>2</td>
<td>Use of the GMBF huller by processors and service providers</td>
<td>Difficult to say, end of 2000s, beginning of 2010s</td>
<td>Farmers</td>
<td>Semi-qualitative - Growth in the surface area cultivated</td>
<td>Focus group</td>
</tr>
<tr>
<td>Increased revenues for traders and service providers</td>
<td>Traders gain from the increase in demand and service providers with the GMBF huller</td>
<td>2</td>
<td>Use of the GMBF huller by service providers</td>
<td>From project end - 2004</td>
<td>Traders and service providers</td>
<td>Qualitative sold/or of service provision</td>
<td>Interviews</td>
</tr>
<tr>
<td>Increased revenues for manufacturers</td>
<td>Manufacturers make revenues from selling GMBF hullers</td>
<td>1 and 2</td>
<td>Production of the huller by the manufacturer</td>
<td>From project end - 2004</td>
<td>Manufacturers</td>
<td>Number of hullers produced</td>
<td>Interviews</td>
</tr>
</tbody>
</table>

The insecurity situation in Mali has greatly limited our study. This is particularly the case of measuring impacts on producers fonio which are determined through a very small number of individual interviews (20) and 2 focus groups in a single production zone. Extrapolating to all fonio producers is made difficult by the absence of accurate national statistics. The measurement of these impacts is mainly based on qualitative data.

Conversely, measuring impacts on the primary supplier, IMAF, proved easier because of the long collaboration and trust established with researchers. We were able to easily obtain data on the number of marketed hulling machines. Harder was to estimate the proportion that the sale of hullers represented in the overall turnover of the company.

Furthermore, we were able to evaluate fairly finely impacts caused by the fonio huller innovation on leaders’ enterprises of cereals processing sector because they also have long collaborated with researchers.