NORDIC CLIMATE FACILITY

Nordic Development Fund • Nordic Environment Finance Corporation

Final Report[1]

Ecological Food Processing Unit, Burkina Faso

Grantee: Danish Technological Institute

Local Partner(s): Isomet s.a.r.l.

Other Partner(s): n.a.

Project start date: *01/05/2013*

Project end date*: 31/08/2017*

__2018-02-20_____	_____
Date	Person responsible (Signature)

_____	_____
ik@teknologisk.dk	IVAN KATIC
+45 72202482	Senior Specialist

TABLE OF CONTENTS

ANNEXES

1. EXECUTIVE SUMMARY

The overall objective of the project is to establish a versatile production plant for some of the most common agro industrial products in Burkina Faso and at the same time demonstrate that such production could take place without use of fossil energy and without connection to the electrical grid.

The system's energy design is a mix of solar thermal energy, biofuel and photovoltaic power and the project involves a quite advanced energy conversion system with many different components connected in an innovative way. The products, rice, attieke (cassava couscous) and dried mango were selected due to their complementarity. They support each other in a way that makes the project financially more robust than if it was only based on a single product. Rice residues provide energy to the processes, cassava generates stable local activity and income, and mango generates seasonal export income.

The local impact of the project is that it reduces the amount of agricultural waste by turning it into energy, and so to add value to the local products. Furthermore, the project promotes the adaptation of sub-Saharan agriculture to climate change by processing and conservation of local crops to reduce post-harvest losses. It also suggests a solution to food security threat resulting from sorghum yield reduction due to climate change. The project focuses on processing of cassava, rice and mango in a combined production plant where rice husk and solar energy runs most of the processes, so that the industrial plant has minimum negative impact on the environment and can even run without grid electricity. The same concept may be adapted to other products and climates.

The project has been implemented in Bama, a village situated in the south west of Burkina Faso. The overall technical concept consists of:

- Building complex with own water supply
- 3 biomass (mainly rice husk) gasifiers for heat and electricity production
- 15 solar parabolas for steam production
- 8 mango dryers with indirect heating and forced ventilation
- 1 rice mill
- 1 Attieke fermentation plant
- 1 packaging system
- 5 large steam cookers
- PV system for light etc.

Pilot production was successfully demonstrated for the following processes: De-husking and steaming of rice, grating of cassava, fermentation and packing of final product (attieke) as well as drying of mango. Attieke (fermented cassava couscous) and parboiled rice is sold locally, while dried mango is mainly for export.

The most innovative outcome of the project is the design of a mango dryer with indirect heating driven by biofuel or solar energy, but the whole concept and integration of different technologies are also new. The local partner Isomet fabricated many of the machines and equipment used in the project, so they will also be able to maintain and repair the production plant in the future.

Even though the overall idea and proof of concept have been verified in the project, it is recommended to change the design to a more cost effective one if it is going to be replicated in the future. To some extent, the project has been too complex and advanced in its technological approach, because other and simpler options have become competitive since the project application was written. First of all, solar photovoltaic (PV) power is now available at very low cost, so a main lesson is that PV could be playing a much bigger role and the thermal solar parabolas should not have been built in the present design because they turned out to be very material- and labour intensive to manufacture. Furthermore, they are maintenance intensive in term of financial and labour input. Unfortunately, 5 parabolas have been damaged by a storm so only 10 parabolas are back.

In general, the project has been implemented as planned, but with heavy delay due to unexpected workload, political unrest in Burkina Faso and weather-induced damage (a roof was blown off). The preparation of the construction site was done from scratch. Key deviations from the original technical design are that the gasifier for electricity is not fully operational by end of the project due to technical challenges (Isomet goes on with adjustments and improvements). It shall also be mentioned that several unforeseen works were necessary to ensure the progress of the project.

The commercial viability was proven for the production and sale of attieke, but the rice turned out to be difficult to sell at a profitable price because there is increasing import of cheap rice. Since rice husk is the fuel for the production plant, a replacement should be found and residues from other industries (shea nutshells) have been tested. Drying of mango was successfully demonstrated in small scale.

As for the climate and development impact, the main outcomes of the project are the establishment of a local production center and income generation in an area that is dominated by traditional farming and low income. The direct climate impact in the relatively short project period is limited, but in the long term, the plant will contribute against climate change by its use of renewable energy in production. Furthermore, the project has a climate adaptation impact by the promotion of the resilient crop cassava.

The production plant is operated by local partner Isomet.

2. ASSESSMENT OF IMPLEMENTATION OF THE PROJECT

2.1 Implementation of Activities

Project activities as per application:

The main activities of the project are described below:

1) *Design verification.*
The actual size of the system and its components will be calculated according to the defined need. As far as possible, the performance will be simulated from existing and validated models. (2 months)

This activity has mainly covered the elaboration of energy balances for the entire system based on the original concept. The energy balance was used to check the size of the energy producing components versus the energy demand for the different processes. The actual results from this initial activity have been the elaboration of a spreadsheet for simulation of drying processes and calculation of the overall energy balance of the production plant. The calculations showed that the project was feasible, if the necessary amount of biomass could be achieved in practice. This initial phase was implemented according to the plan.

2) *Construction.*
The ovens, the energy systems, the wet and dry process the packaging system line as well as the building will be purchased and constructed from industrial products with proven reliability in a hot climate developing country. The practical construction will be performed by Isomet and local contractors with guidance from DTI. (9 months)

In this phase of the project, the most of the effort has been on the buildings, which took much longer to construct than expected. Furthermore, the construction was more expensive than expected, causing a cash flow problem for the project. Many unplanned but necessary works had to be done to make the whole complex useable. A major incident happened when a large roof surface blew off during a hurricane and had to be rebuilt before other work could be resumed.

While waiting for the constructions to be ready, Isomet manufactured some of the locally made components for the processing plant, i.e. cassava press, mango dryers, rice dryers, gasifier and water tanks. Due to the lack of high quality materials and tools it was difficult to manufacture all parts to the desired level of quality, however they are easy to repair locally.

A severe delay occurred due to difficulties with the selection, purchase and installation of a biomass gasifier for electricity production. A lot of time was spent with survey of various more or less commercial designs because it was important to find a product that could produce sufficiently clean gas to run an engine. A version combining Finnish gas cleaning unit with an Indian generator was selected and is in function. ISOMET had to construct additional filters in order to clean the gas to be used in the generator. Currently, the project uses a diesel generator until the genset

is 100% up running. The gasifiers for steam production are running well and are not that critical. The gasifier is a good example of successful technology transfer and necessary adaptation to local production methods.

3) *Optimization.*
All the system will operate under the guidance of DTI and ISOMET and optimized according to the local conditions and products. (6 months)

The optimization of the production processes has been based on a laboratory study of mango drying done at DTI combined with an experimental approach on site in Bama. Due to delay, the project missed the planned mango season, so the laboratory results could not be implemented in practice before end of the project, where there was a bad harvest and lack of mango. Other optimization effort was done locally on a trial and error basis, such as the best fermentation process and packing of attieke. In this phase, DTI has only been present on a short-term mission, so most of the work with final construction and optimization was made locally and supported by DTI through skype, phone or mail correspondence. Special attention was given to the design of the mango dryer, where a new and efficient design was developed.

4) *Training and capacity building.*
Selected local workers will be trained as part of the project, so they will be able to run and maintain the production plant also beyond the project period. (3months)

Training of local workers has taken place as planned, but not to the scale anticipated in the application. Mango peeling and drying expertise was found in another company (using gas for the process) and women from this company were hired to transfer knowledge to the current project. For the machinery and process plant, Isomet used its own engineers. The following staff has been trained as part of the project.

Technical maintenance: 12 own staff members plus 3 from COVEMI[2] and 3 from WOUOL Association[3] (The association has other private companies as clients.)

For the food processing 25 women (local village) have been trained for the processing of cassava, mango and parboiled rice. Average female employment is around 10.

5) *Commissioning and evaluation.*
The process as well as the final products will be evaluated by experts in industrial systems and food technology. Some adjustment of the process will be part of this activity. (2 months)

This activity has only been realized on a basic level due to delays. Instead of experts, the quality of the products was evaluated by the relevant market contacts in

[2] http://ouaga-museedelamusique.blogspot.com/2009/05/la-chaux-de-covemi-au-burkina-faso.html

[3] www.wouol.org

Burkina Faso. For the production of attieke, the result was not satisfying for the first batches. The colour was brownish, and it turned out it had to do with the packaging process. After change to another packaging material, the quality was acceptable. It was sold in the street or given away as promotion.

The estimated total production volumes could not be met within the planned period, but all processes have been verified and the pilot production documented.

6) *Promotion of the unit. Actors in the field of politics, institutions, business, R&D and NGO's are going to be invited to a guided tour at the unit to display the technology and the opportunities it brings. (2 months).*

ISOMET invited various important persons to visit the site and promoted the project on a number of occasions:

Visit of a World Bank team
Visit of GIZ
Visit of the director of Covemi (Chamber of Industry and Commerce)
Visit of the Association of cashew nut producers
Visit of the Research centre for agriculture "farakoba"
Visit of the "Direction regional de agriculture"

Meeting participation:

- Forum sur « l'Accès des Femmes aux Technologies Appropriées » prévu du 24 au 26 mai 2017 à Abidjan, Côte d'Ivoire.
- Participation in « 30ème réunion du GIMAC » du 27 au 28 juin 2017 in Addis Ababa/Ethiopia
- Many local meetings with cashew nut, cassava, mangoes, producers resulting in projects for shea butter production, cashew nut processing and even limestone processing into quicklime.
- ISOMET has been also invited to take part to the MCC 2. Compact definition meeting.

2.2 Deviations from the Planned Activities

2.4.1 Activities that have not taken place

The planned activities have basically taken place, but with several deviations. Not all the technical installations are running as predicted, but the plant is able to produce the products it was intended for.

A final visit by DTI to the site in Bama had to be cancelled due to changes in the official travel guidelines from the Danish Embassy in Burkina Faso, warning against possible terrorist acts. Consequently, DTI asked a local consultant to document the project results. (Consultant report sent with Milestone 4 progress report)

2.4.2 Unforeseen activities that have taken place

Most important is some additional construction work: The buildings had to be bigger than expected, the terrace was unforeseen, additional toilets, the terrace roof, and two shelters for the machines were constructed.

Unfortunately, a storm carried away the roof of the hangar that was under construction, imposing damages of almost € 12,000. The roof was ripped of the drying building, which prevented us from starting the mango drying as planned.

- 350 m^2 terrace, was necessary as a working place, as not having a terrace was very dirty and did not comply with regulation.
- A roof on 175m^2 to cover the terrace; otherwise it was impossible to work on the terrace in hot season
- Additional shelters were built. Some machines cannot be installed inside due to smoke. Therefore, they had to be installed outside on a concrete platform and covered because of the rain. Three shelters were necessary, one for the steam production a second one for the rice de-husking machine and a third one for the power gasifier.
- Toilettes for the workers are the main additions. One toilet was planned in the building but was only for office worker and would not be enough for all the production workers. Therefore, we had to plan two toilets and one shower room outside.
- For the growing of cassava 10 hectares of land has been acquired by the local partner. (not part of the project, but showing his interest in long term expansion)
- Four gasifiers were finally installed instead of two. One gasifier is planned for the steam production in the daytime, a second smaller one is planned to fire the drying in the night. The two other big gasifiers will provide the genset with syngas.

2.3 Achievement of Outputs and Objectives (also see Annex 3)

Planned Objectives and Outputs	Indicator(s):	Achievement of the objectives and outputs:
Objective 1: A renewable energy based processing unit is installed in Burkina Faso	Existence of an operational renewable food processing unit	
Output 1.1:Pilot plant implemented	Physical evidence	The production plant has been constructed with some deviations when compared with the application. Photo documentation and site visits have been performed.
Output 1.2: List		
Objective 2: The technical feasibility of a renewable energy based processing unit is demonstrated	The operationality of the renewable energy based food processing unit	
Output 2.1: Technological maturity demonstrated		The plant is able to operate and pilot production is proven. Samples of final products documented by photo and/or independent evaluation.
Objective 3: The economic viability of a renewable energy based processing unit is demonstrated		
Output 3.1: Income generated	Isomet account.	The income from product sales has been lower than expected, partly because the quality of the

		local rice (used in the process) was inferior to imported rice.
Objective 4: Jobs are created in the rural area.	Workers are hired for the site	
Output 4.1: 53 jobs created	Isomet register	The job depends on season. In the peak season for rice we have up to 10 females more and when we are doing the cassava paste for storage we can go up to 20 females more.
Objective 5: Local resources are processed and value are added to local products	local products are purchased for processing	
Output 5.1: 2022 tons attieke produced	Isomet register	Actual production in the project period 27 t
Output 5.2: 20 tons dried mango processed per year	Isomet register	Actual production in the project period 500 kg
Output 5.3: 2022 tons attieke produced	Isomet register	Actual production in the project period 62 t
Objective 6: Communication actions are organized to present the renewable energy based production unit.		
Output 6.1: Press conference		Article in Danish renewable energy magazine by DTI Isomet arranged a number of visits and promoted the project

3. CLIMATE CHANGE

The project concerns climate change adaptation and mitigation. By using renewable energy for the production unit an annual emission of 1800 tons of CO_2 could theoretically be mitigated when the plant is 100% utilised. In reality, this figure has been less in the project period due to the reduced production volumes, but as production ramps up it is still a valid estimate. It must also be mentioned that some of the electricity production is still based on diesel until the biomass gasifier becomes running in a stable way. The actual net CO_2 savings from pilot production is approximately 70 tonnes during the project period. In practical production with the current plant capacity the emission reduction is calculated to 450 t/year. This requires that storage silos are built for the raw products, and thus further investment. Better storage facilities will increase income, as products can be sold when the market price is right.

As for the climate change adaption, the access for local farmers to sell cassava is an important achievement with respect to climate change adaptation. Cassava has a yield of about 10 tons/ha, is tolerant to heat and drought and can generate a more stable income than the traditional crops that suffers from climate changes in the region. Sorghum and maize has a yield of only 2-3 tons/ha. Isomet also bought own land for cassava growing, for the same reason.

4. DEVELOPMENT IMPACTS AND CROSS-CUTTING ISSUES

In the project application, an important aim was to employ local workers directly at the production plant or indirectly through improved sales from local farmers. Since food processing is traditionally a women's job, main staff is mainly female. The average during the project was 6 female and 4 male employees, but in full production the number of female workers grows to more than 20. There are plans for a total staff of 50 in the coming years. Food processing is an activity mainly done by women and the ratio female/male in the sector is 8/2. In this way, the project contributes to increased income generation and gender equality.

Environmental sustainability is another cornerstone of the project in more ways: a) replacement of fossil fuels and unsustainable fuelwood with solar energy and biomass residues b) reduction of agricultural waste, mainly from mango production and c) promotion of "ecofood" for the export market. A subsidiary sales company *Tere Dia* (taste of the sun) was founded for distribution of the final products.

4.1 Relevance

The project is fully in line with regional efforts to make sub-Saharan Africa more resilient to climate change and increase agricultural productivity. Isomet has invited local stakeholders to the project site and received very positive feedback. Contact is established to GABIFASO biogas project for support of biogas in BF. GIZ could be an interesting partner in their project Powering Agriculture.[4] The project has initiated several spin-off activities for Isomet.

4.2 Effectiveness

The project could have been more effective if the planning and execution, but the working conditions in Burkina Faso are difficult and unpredictable, so it was not possible to plan everything. For example, political violence and unusual weather had quite some influence on the project. The communication between DTI and Isomet was sometimes difficult due to missing internet connection and bad telecom signal.

4.3 Efficiency

The actual work carried out in the project period was considerable and higher than expected per the application. The project turned out to be underfinanced due to some unexpected difficulties and cash flow challenges.

4.4 Impact

The main impact of the project is that the local farmers now have a centre where they can have their products processed, conserved, and consequently sold at a better market price than if it was sold as raw product just after harvest. The

[4] https://www.giz.de/expertise/html/18089.html

production plant creates local employment, reduces post-harvest losses and increases food security. It is estimated that 170 of the local population have a direct benefit of the plant.

4.5 Innovativeness and learning

A number of components have been locally designed and manufactured during the project such as gasifiers, mango dryer, rice dryer, adapted gasifier design, gasifier for electricity, open steam cooking pots. The whole idea of combined product processing is highly innovative, and it will in the near future include cattle and biogas to complete the circle (cattle to be fed on residues).

A very important lesson from the project is that the complexity and technical challenge must not be underestimated, especially when many functions depend on each other. When partly experimental components are used, it takes a lot of time and effort to reach good regularity in production. Furthermore, cost efficiency for some of the locally produced components is too low to recommend this solution in future plants. Import of standard systems may be a better option, but of course, it reduces local employment opportunities when equipment is produced abroad, solar parabolas as example:

After having constructed a number of solar parabolas for the current project and another in Dano, the project partners have concluded that the solar thermal energy system is too complicated and expensive to manufacture compared with the benefits. In the current project there seem to be more than sufficient bio residues available for running a gasifier + genset for electricity and another gasifier for steam production. The solar option may still be worthwhile in other projects with less available residues but in such case, we recommend to use simpler linear concentrators or high temperature plat plate collectors as a more cost effective option. The Schaeffler concentrators have a potential for high temperature steam production, but due to necessary changes in the system design, this will not be fully exploited. PV has also become much more cost effective in recent years, and could replace the generator.

5. SUSTAINABILITY AND POTENTIAL FOR SCALING UP AND FOLLOW-UP INVESTMENTS

The project partner Isomet are committed to continue operation of the production plant beyond the project period, as the owner has a personal economical interest in this. The business has to be developed step by step and will not be ramped up as fast as it was planned due to lack of capital and changes in market conditions. The most promising plan seems to be to run the processing plant on commercial conditions, offering the local and regional farmers an opportunity to conserve their harvest and increase its market value. (For example the service of storing and de-

husking rice or drying of other crops than just mango. We already tried for rice, as detailed in Annex 2)

The project mainly employs local women, hired on a temporary basis after harvest season for the different products. The project has resulted in local job creation and provides better security for local farmers, who can sell near the place of harvest.

The environmental sustainability is good (see environmental impact report from the initial phase) but not perfect, since some diesel power has been used for electricity production. When enough capital is accumulated, a PV standalone system could replace most of the diesel. It must also be mentioned that without the production plant, a lot of harvest would be lost with associated negative environmental impact. The system is largely using biomass residues that would otherwise have been burned or rotten.

The site is already prepared for scale up as the fenced area is 4 x bigger than needed for the current production capacity. A new rice field-developing project is under way in the region, providing an interesting market opportunity for rice processing. The idea of using biomass residues for this type of process plant can easily be replicated. The solar thermal part has to be revised, but is still relevant where there is less biomass available. Production of dried mango for the local market is ready to run for 1 year before export production will begin within two years. Isomet already contacted the company sugar Helsinki https://sugarhelsinki.com/ regarding requirements for import.

6. FINANCIAL REPORTING

The financing for the project is found in the following table.

Table 1. Costs and financing.

	Costs,EUR	**Financing, EUR**						
Organization		**NCF**	**Grantee**		**Local partner**			
			Cash	In-kind	Cash	In-kind	Revenues	Total
Grantee	98856	83038	1397	14421				98856
Local partner	363823	257450			88043	15335	2995	363823
Total	**462679**	340488	1397	14421	88043	15335	2995	**462679**

7. CONCLUSIONS AND RECOMMENDATIONS

The overall conclusion of project is that the basic idea has been proven and the partners have succeeded to establish a local production plant for typical Burkinabé agricultural products, but with a lot of challenges. Due to the complexity of the design, some difficulties were expected, but they turned out to be different from those foreseen.

The power gasifier was supposed to be the biggest problem but, it turned out that a research program on power gasifiers was ongoing at the 2IE Institut International de l'Eau et de l'Environnement[5]) and we received have help from them. Other difficulties were many, such as underestimated construction costs and unexpected repair of a large roof.

Financial issues: the Burkinabé bank system is tough and Isomet could never get the amount of credit wanted, so we had to self-finance step by step in the enterprise. Furthermore, Burkina got an insurrection and a military putsch that made the business go worse. Isomet did not get any contract for one year, and pre financing was difficult.

The most important lesson has been not to underestimate the time needed for construction of the buildings and infrastructure, which is the basis of the production plant. Especially in a developing country, it can be difficult to get things done as originally planned for, and some flexibility is needed.

Regarding the technical design, the Schaeffler concentrators (i.e. parabolas) have proven a potential for high temperature steam production, but moderate temperatures are sufficient for the current plant. It is therefore recommended to use another and more cost effective type in future projects or go entirely for biomass in the steam production. It is also recommended to use photovoltaic power in larger scale for provision of electricity since PV has become much cheaper. The steaming and drying systems worked well and do only need small adjustments.

Regarding the socio economic activities, the main conclusion and recommendations are that the project was partly successful as creator of local employment for women, and rural population in general, but that the terms of employment have to be more regulated and secure than they are now. This can only be realised if and when the production and income from the unit becomes more regular, i.e. by integration of new side productions and services such as food storage facilities (food bank or rural service center).

****

[5] http://www.2ie-edu.org/

Annex 1 Pictures

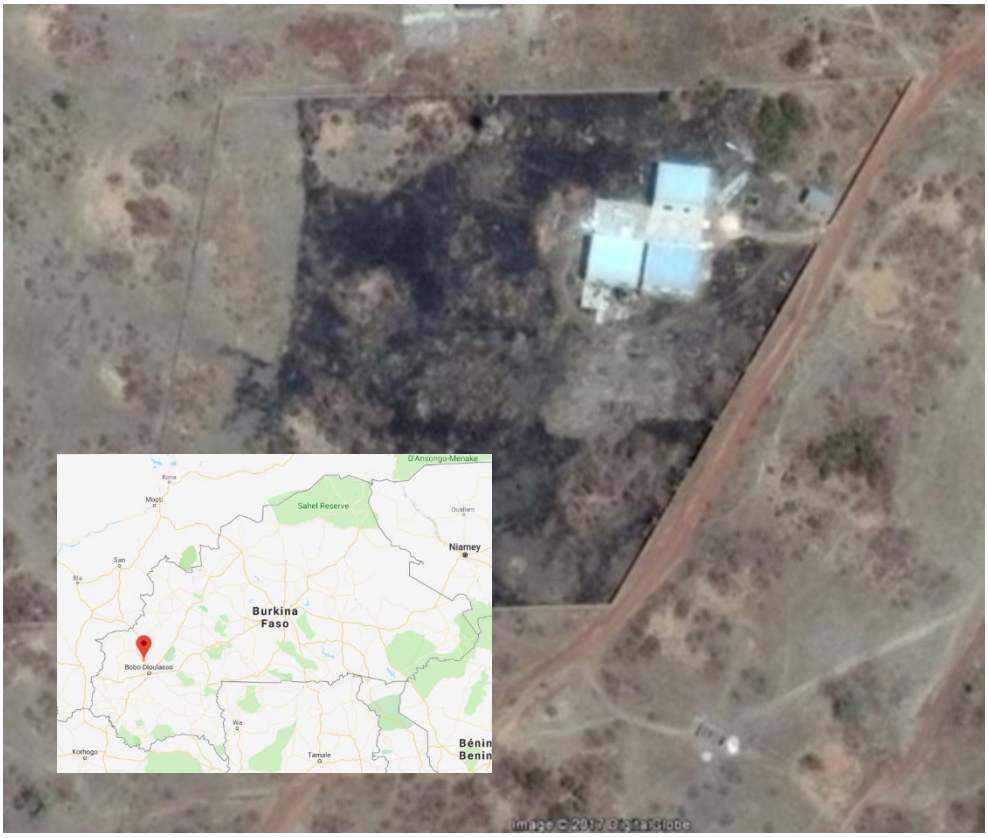


Figure 1 Google view of the project site in Bama

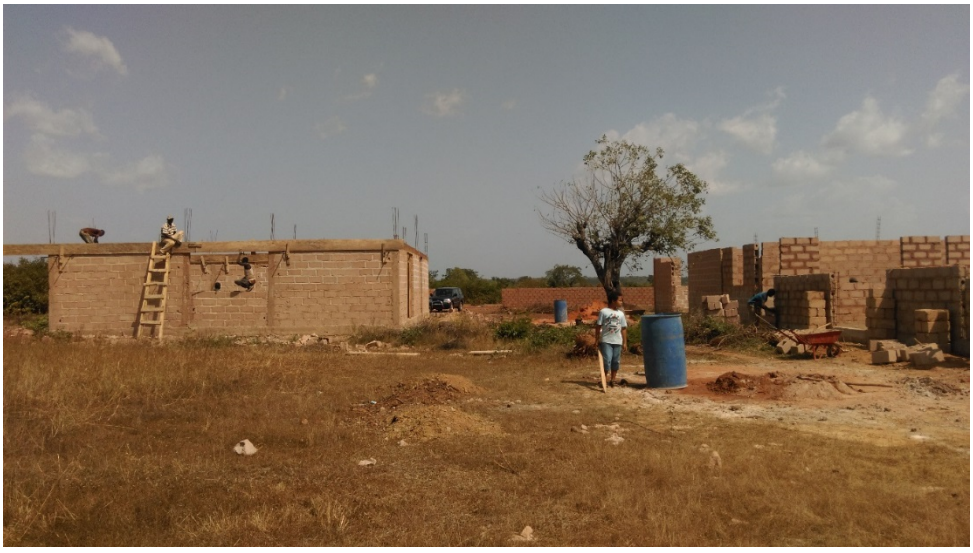


Figure 2 Site under construction

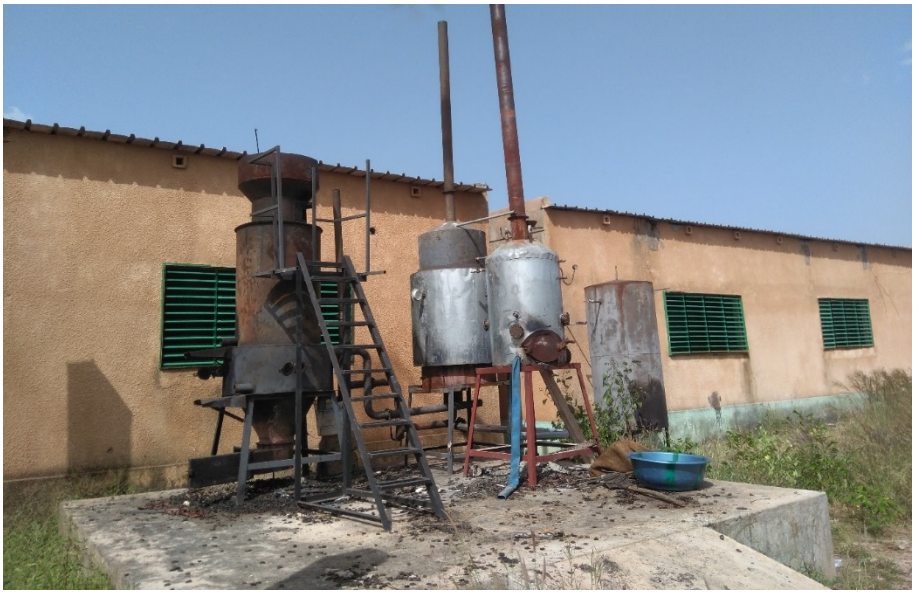


Figure 3 Boilers and gasifier

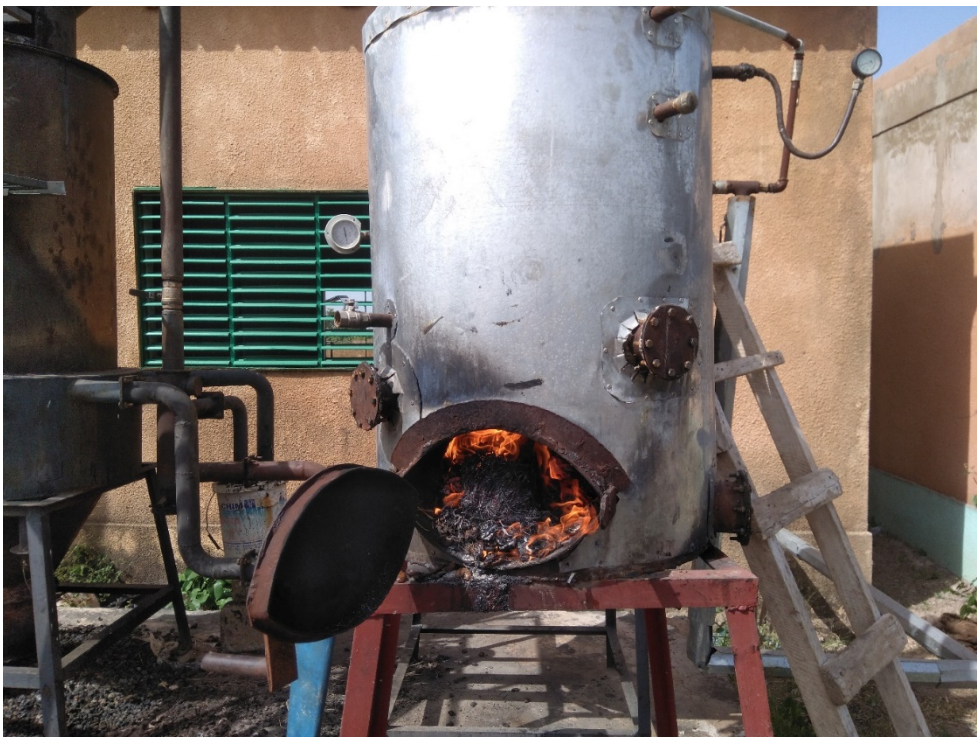


Figure 4 Biomass boiler

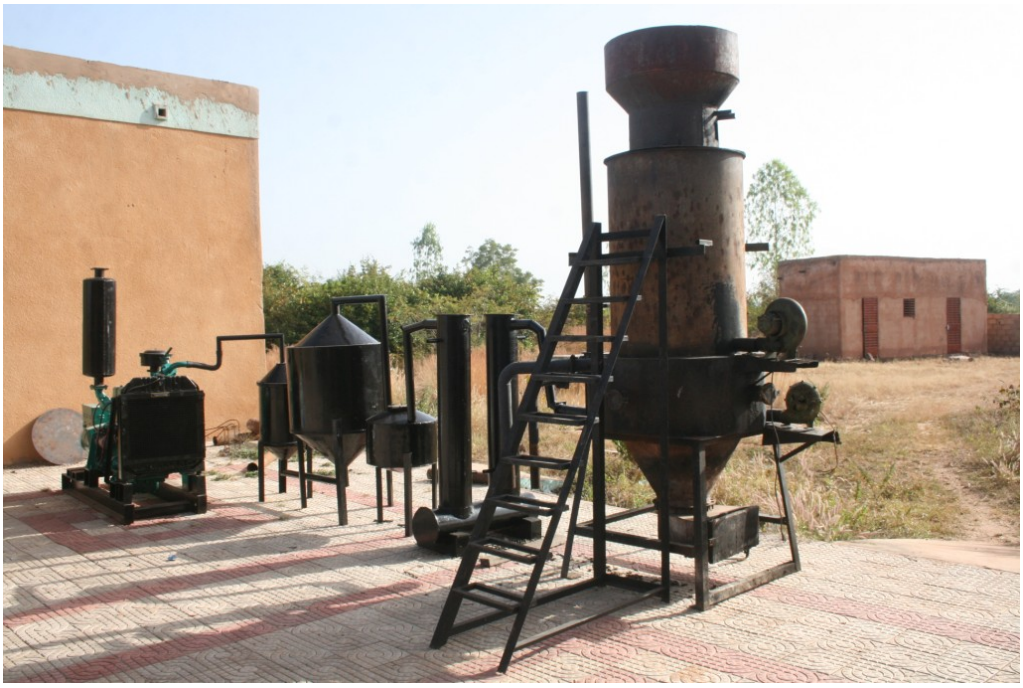


Figure 5 Installation of genset and gasifier for electricity

Figure 6 Parabola field

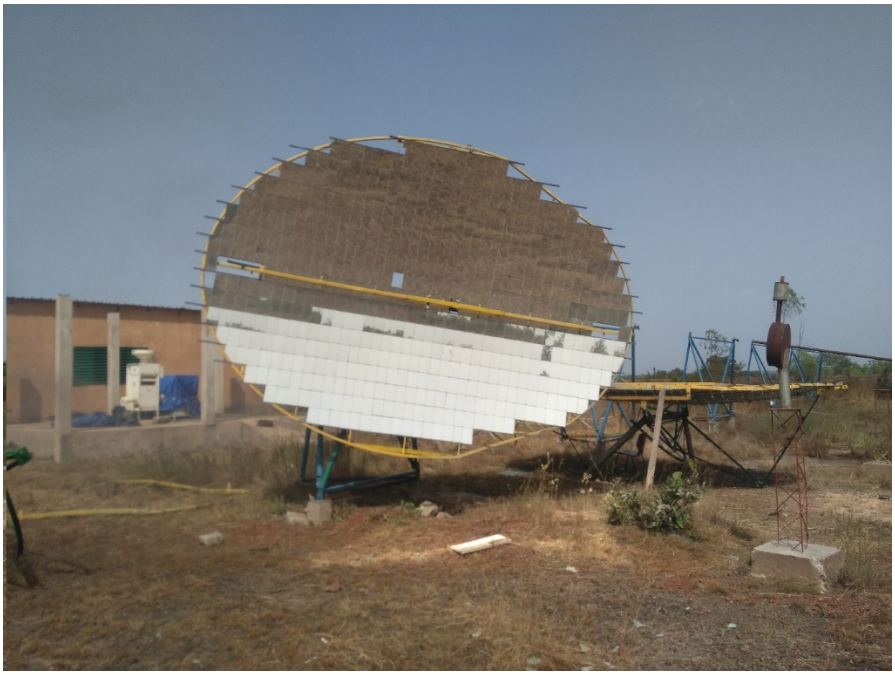


Figure 7 Detail photo of parabola

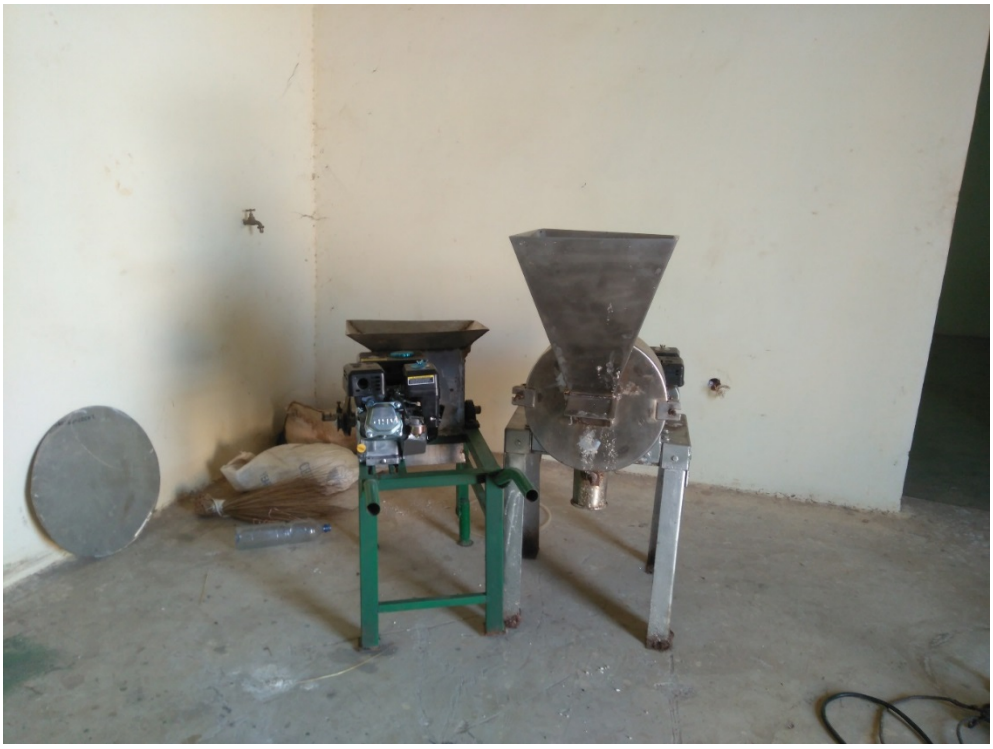


Figure 8 Cassava grating machine made by Isomet

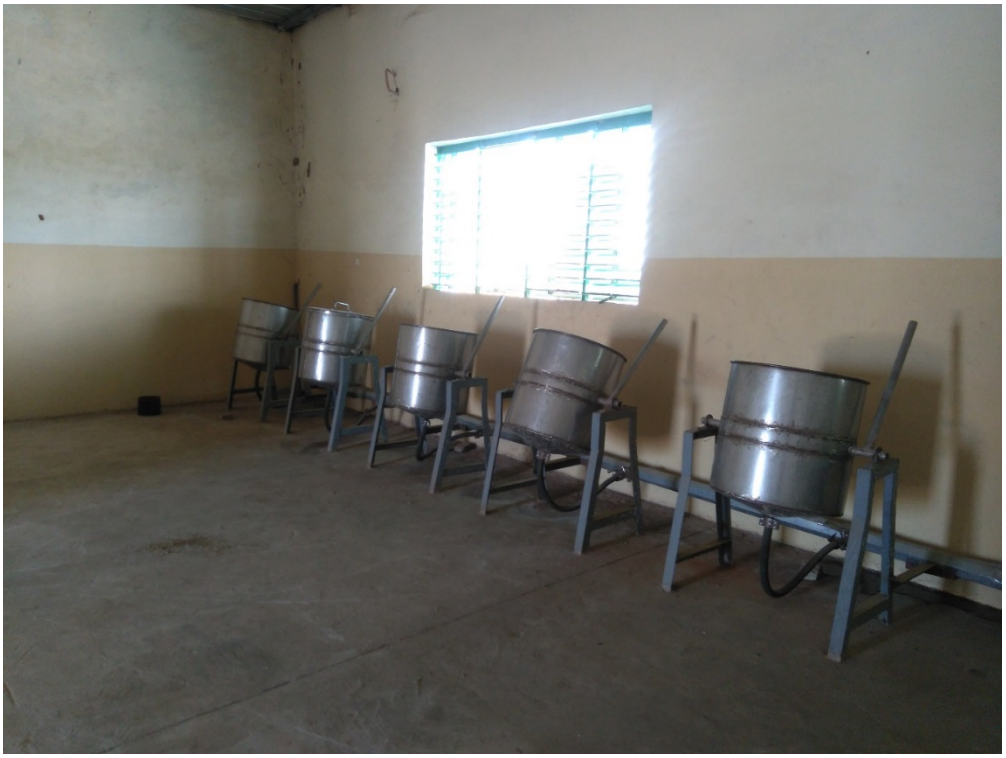


Figure 9 Cooking vessels in the steaming room

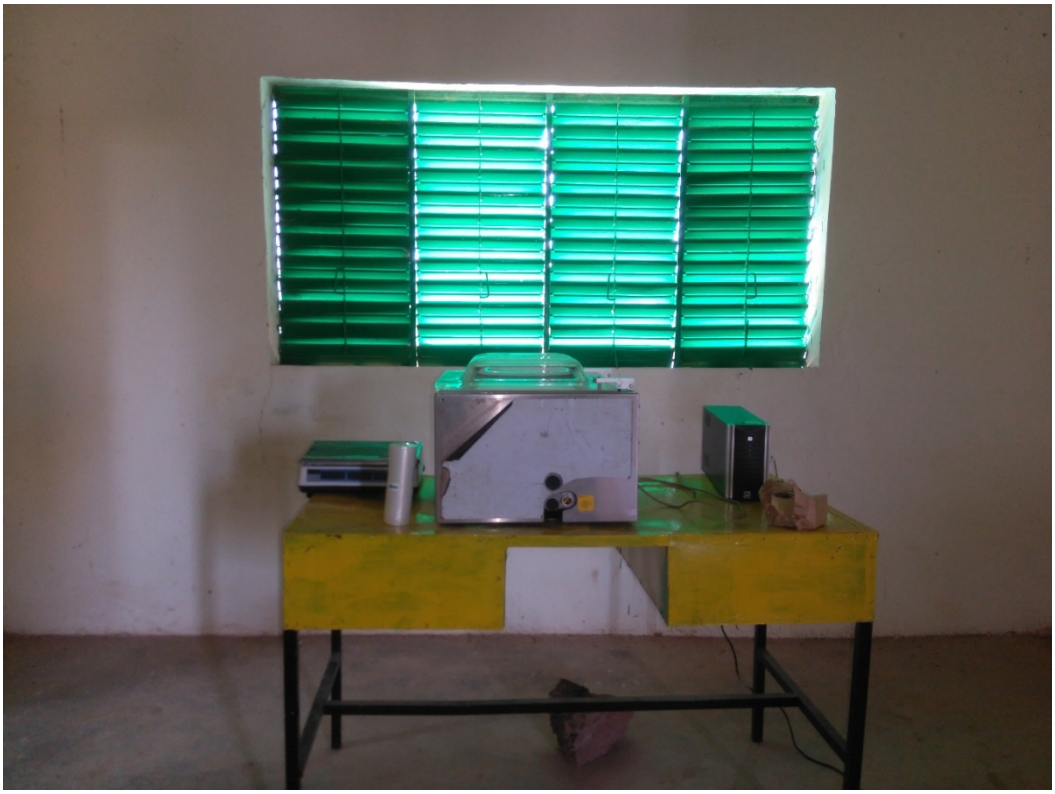


Figure 10 Packaging machine for vacuum packs

Figure 11 Mango dryer and pilot production

Mango could easily be sold to international corporations at a profitable price. The production capacity 50-100 kg/day demonstrated

Figure 12 Cassava ready for processing

Figure 13 Peeling of cassava

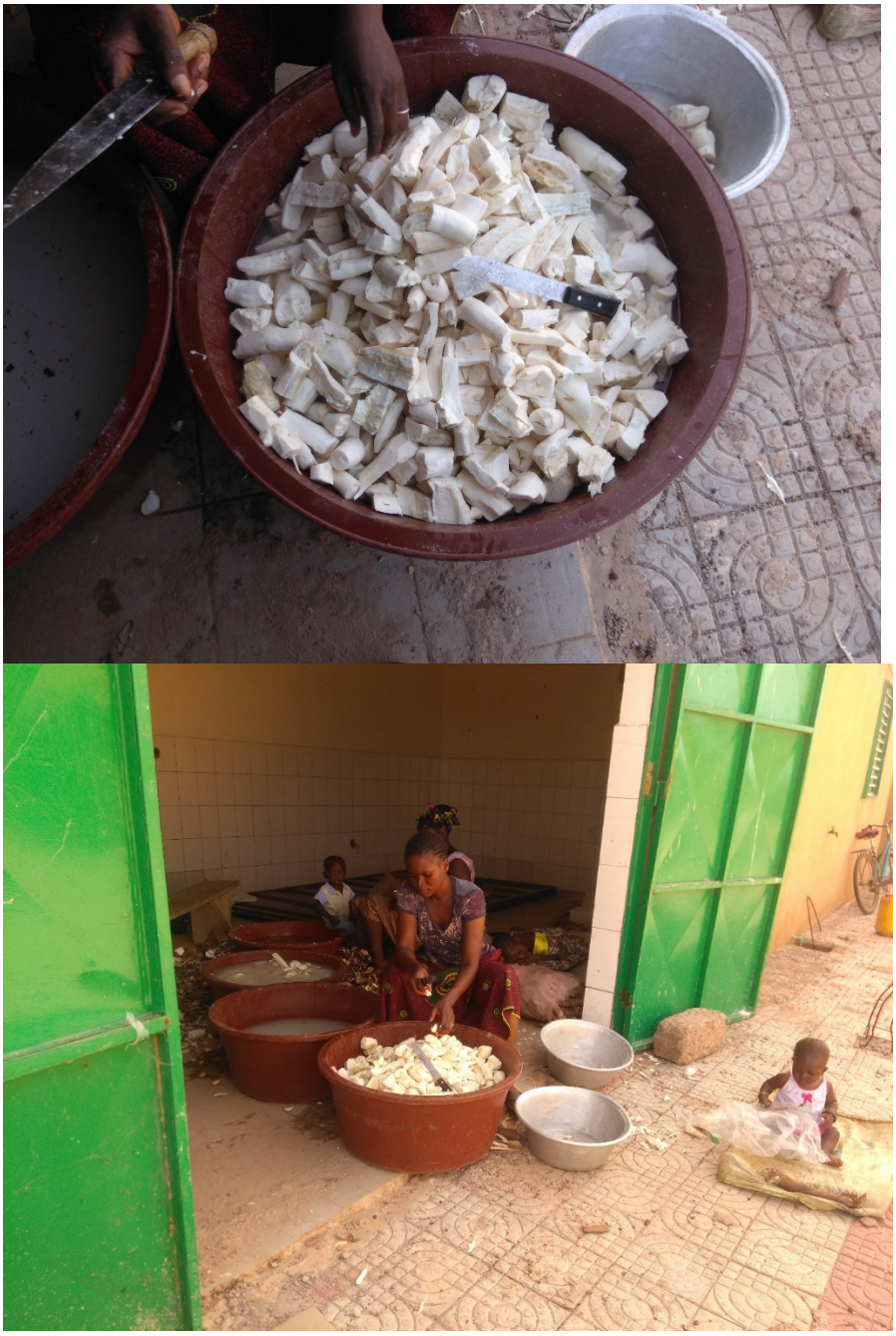


Figure 14 Cut cassava

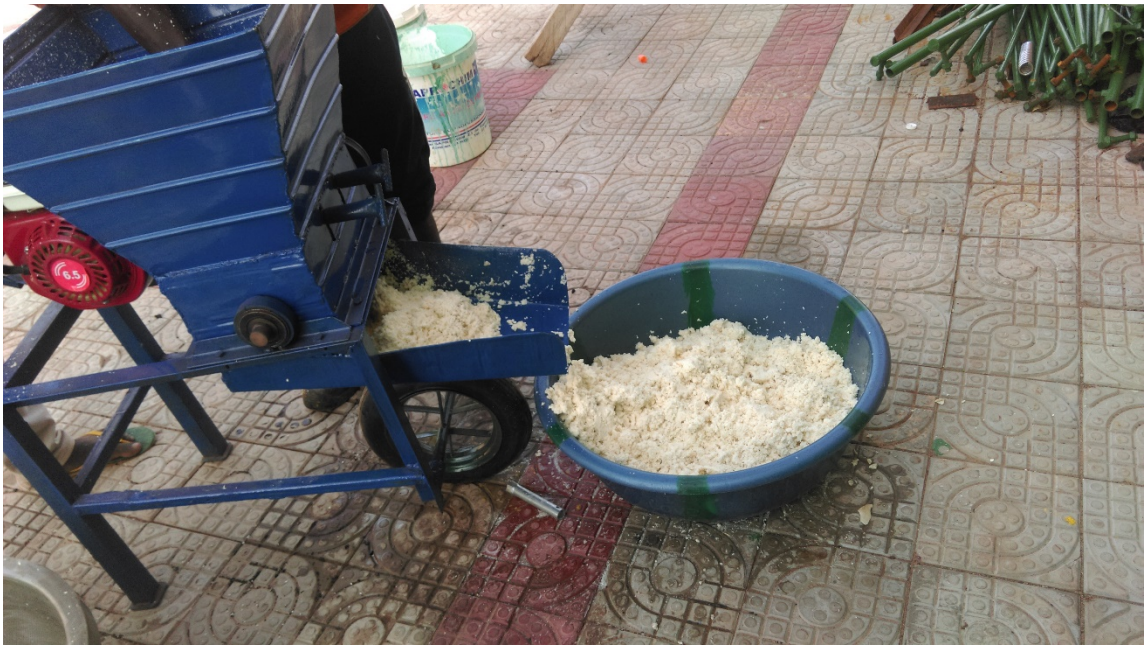


Figure 15 Cassava grating

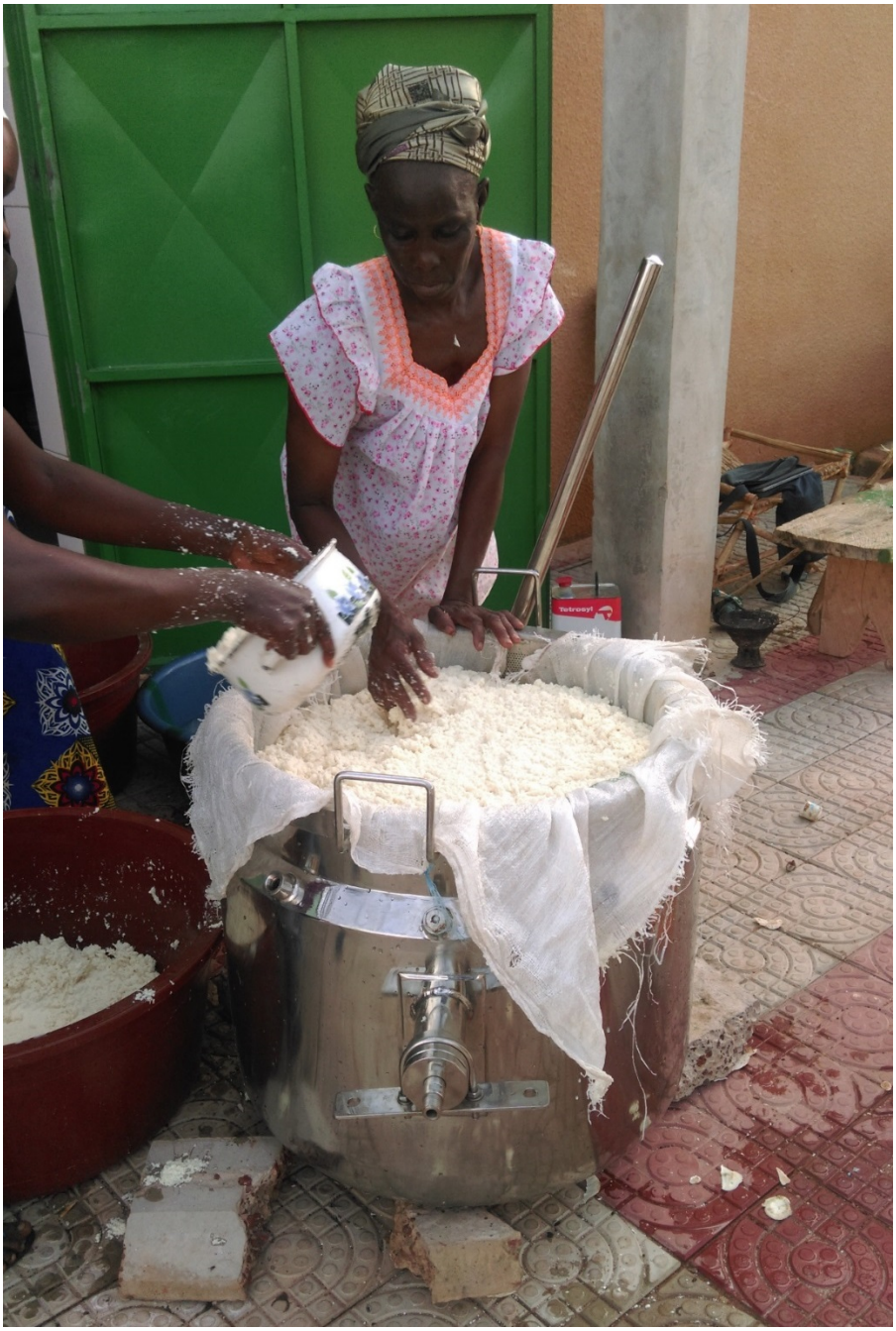


Figure 16 Fermentation of cassava

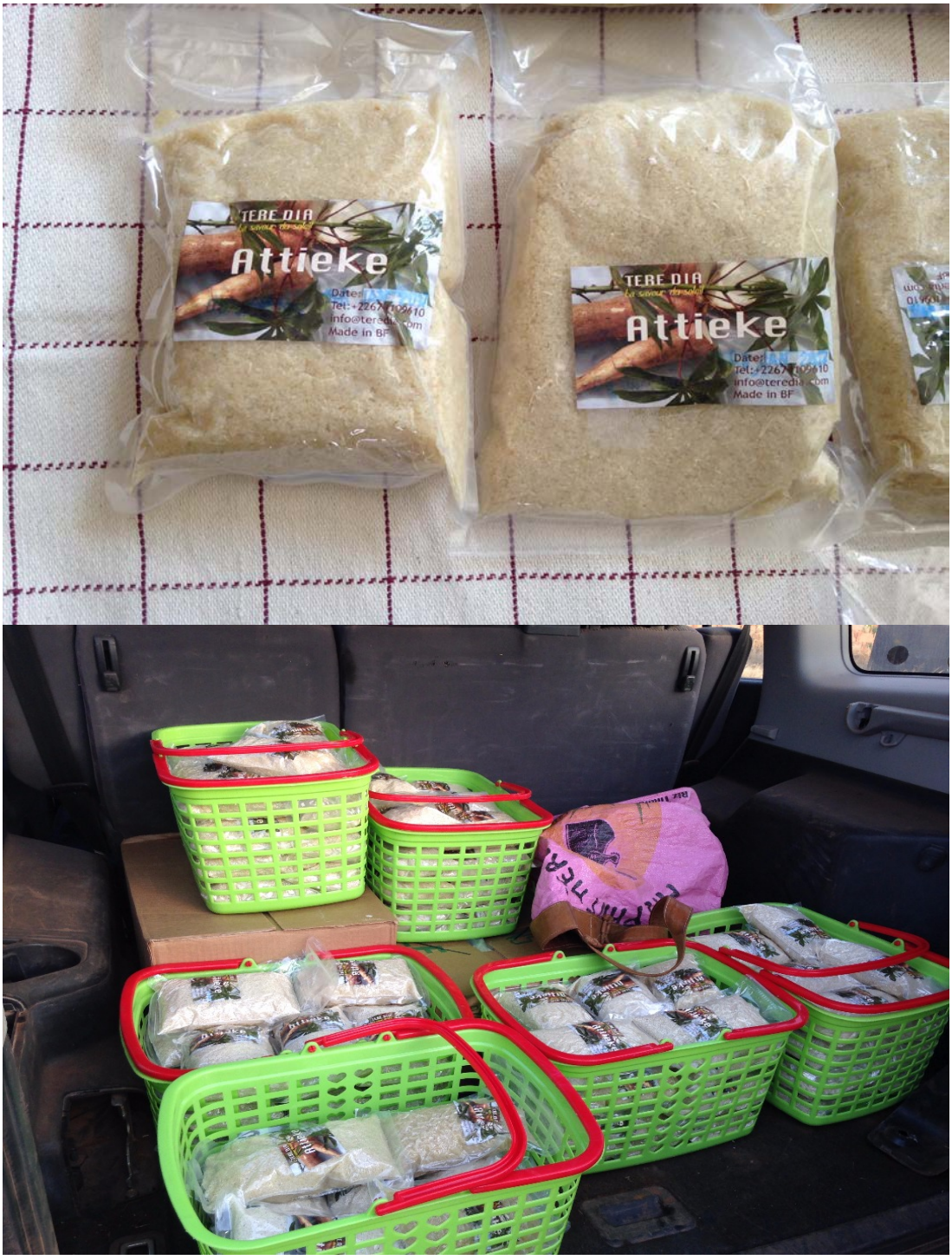


Figure 17 Final product

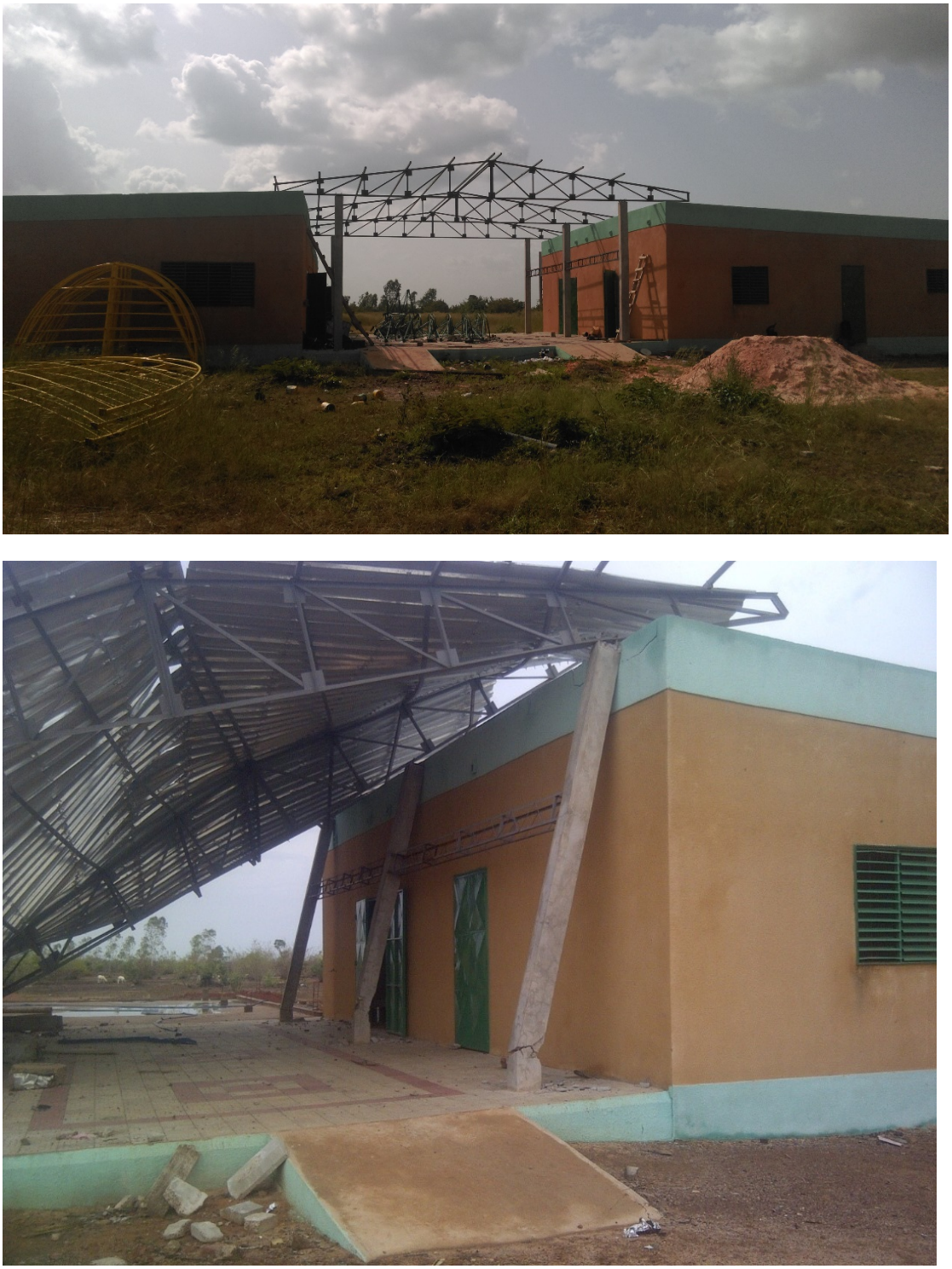


Figure 18 Overview of production plant and storm damage

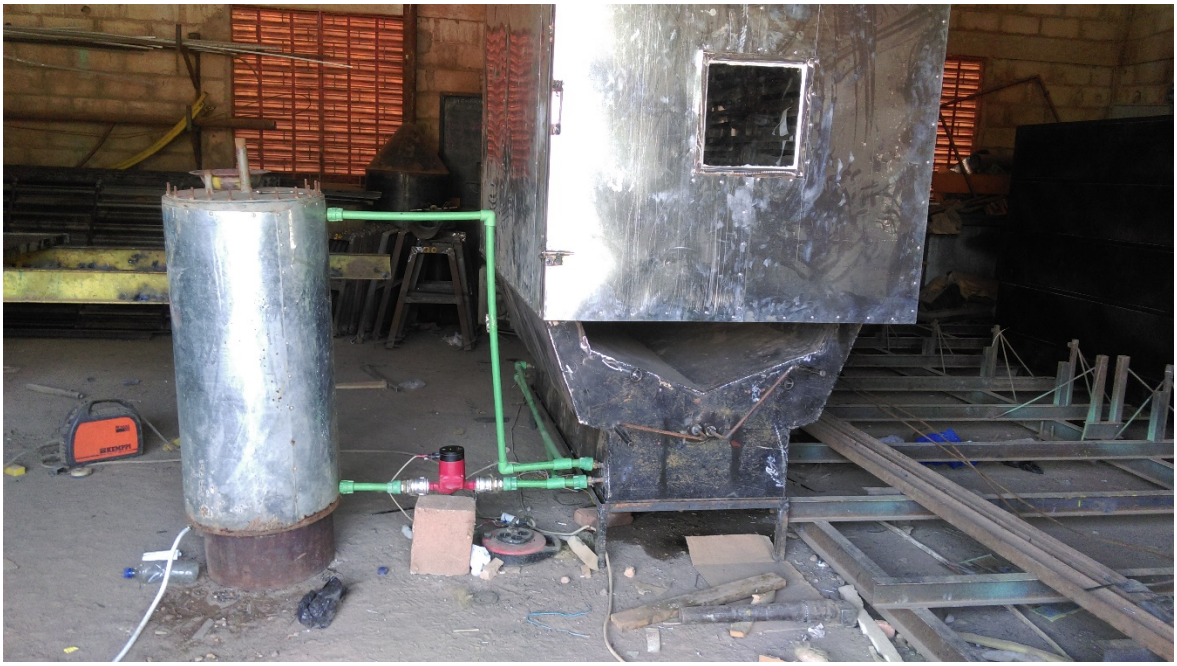


Figure 19 Test of mango dryer with indirect heat

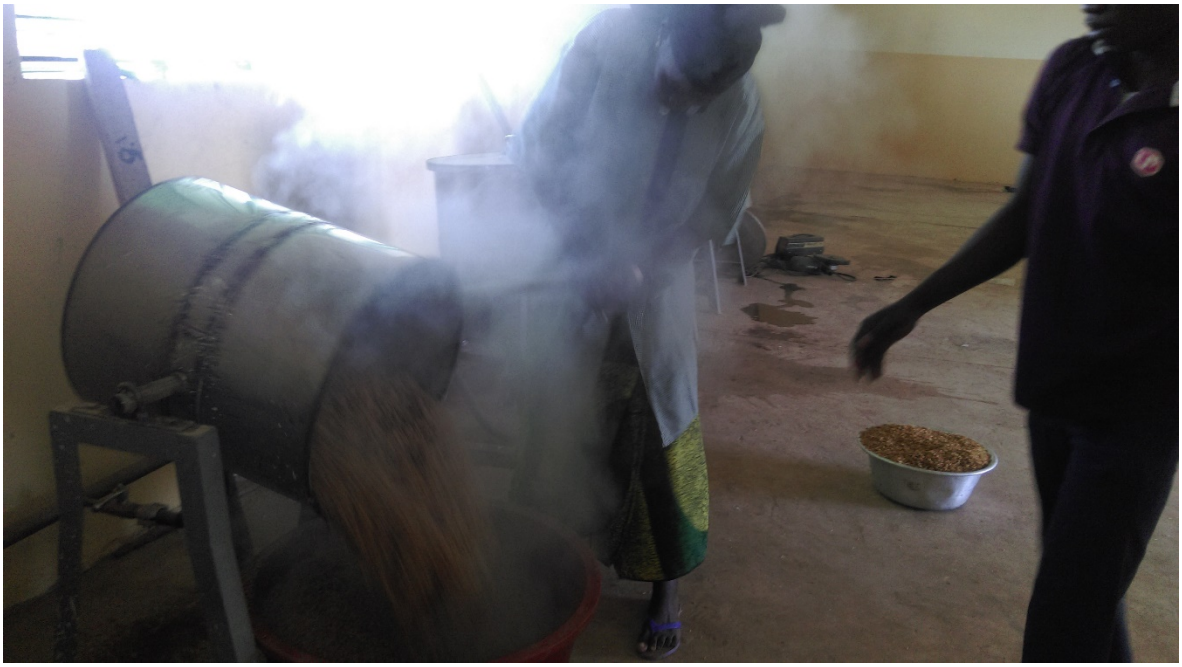


Figure 20 Rice steaming (10 minute per 75 kilo)

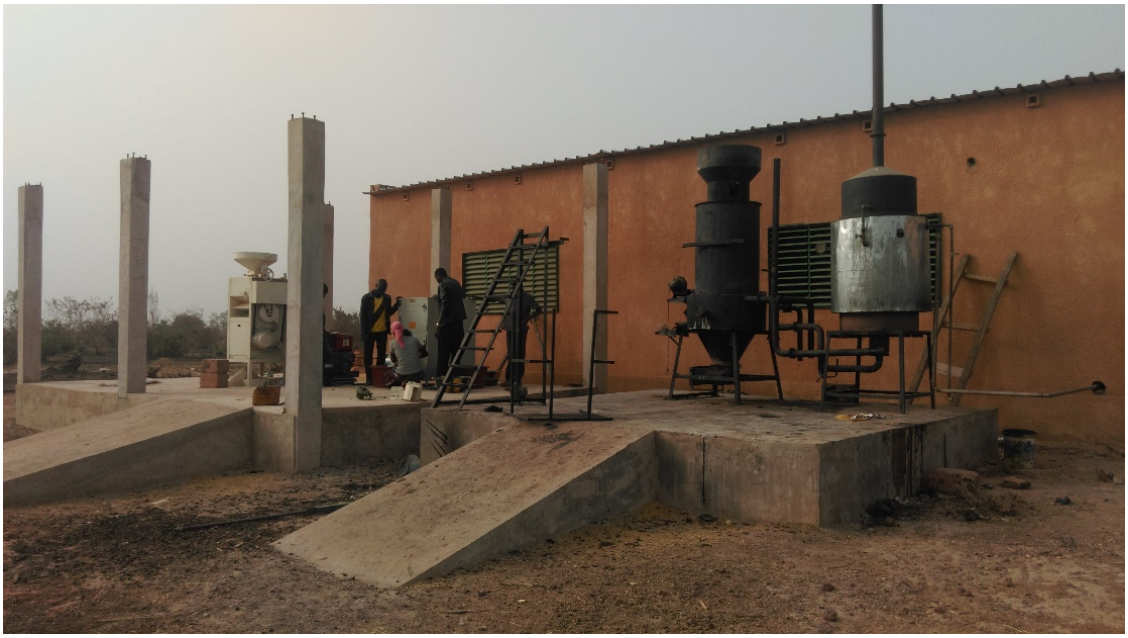


Figure 21 Installation platform for gasifier and genset

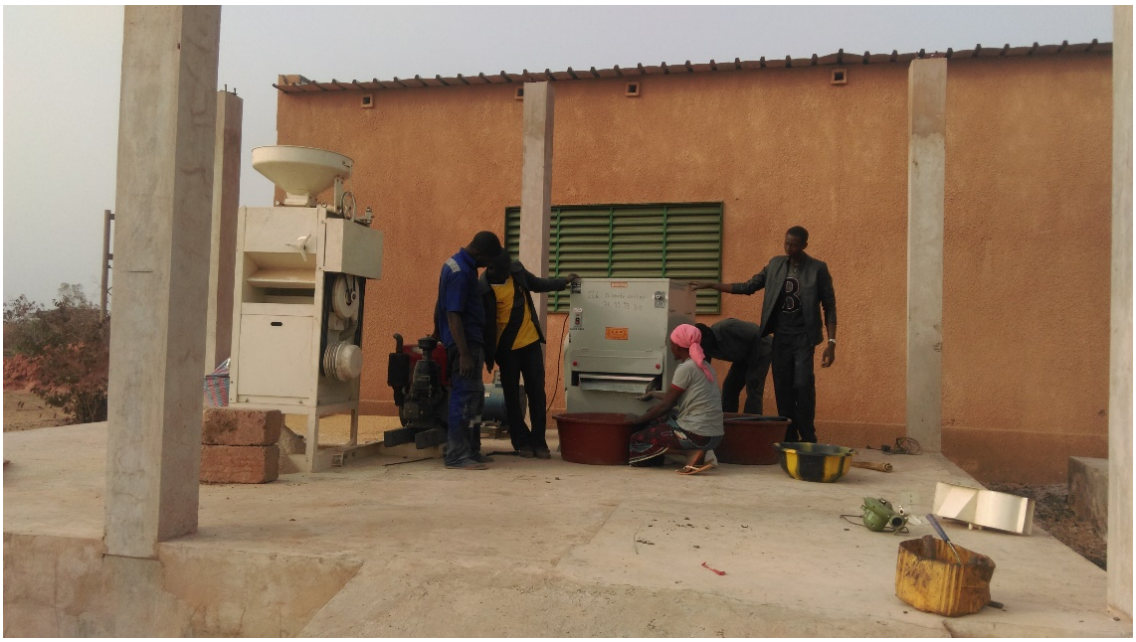


Figure 22 Cleaning of rice

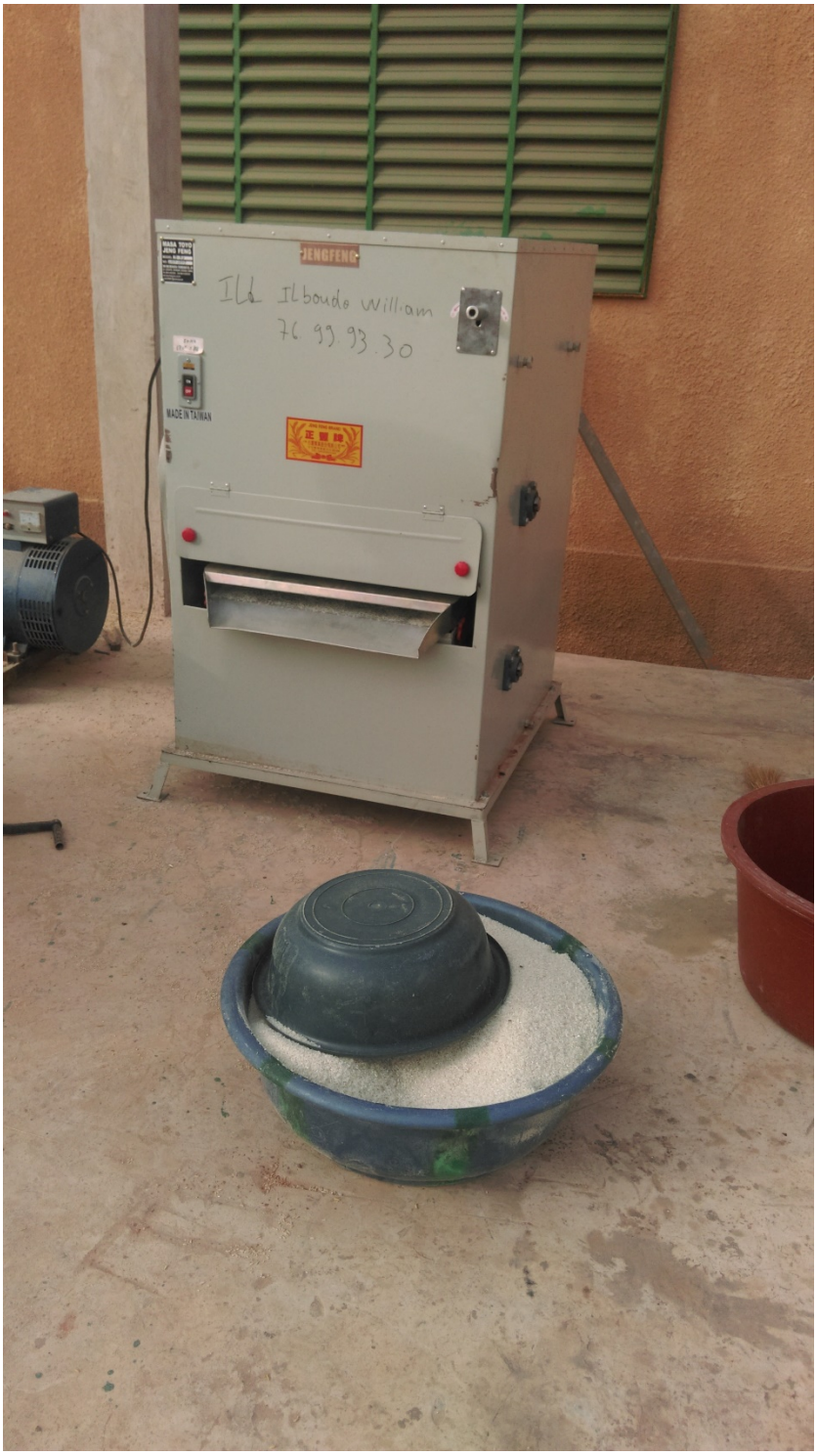


Figure 23 Rice cleaning machine (removal of stone)

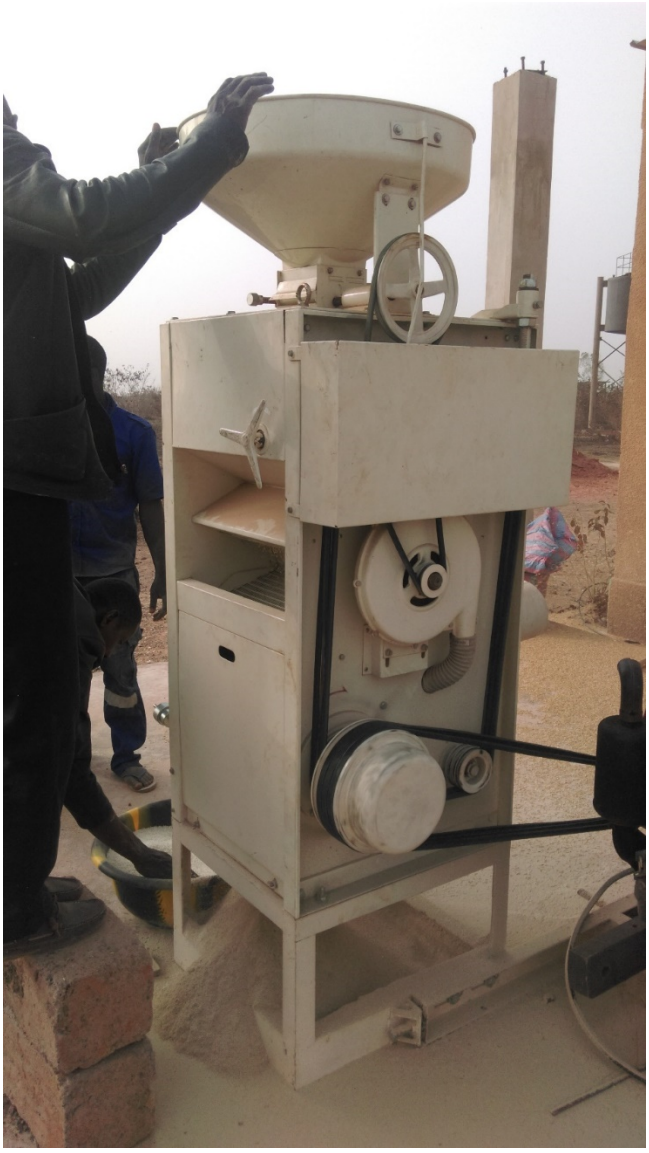


Figure 24 Rice huller in action

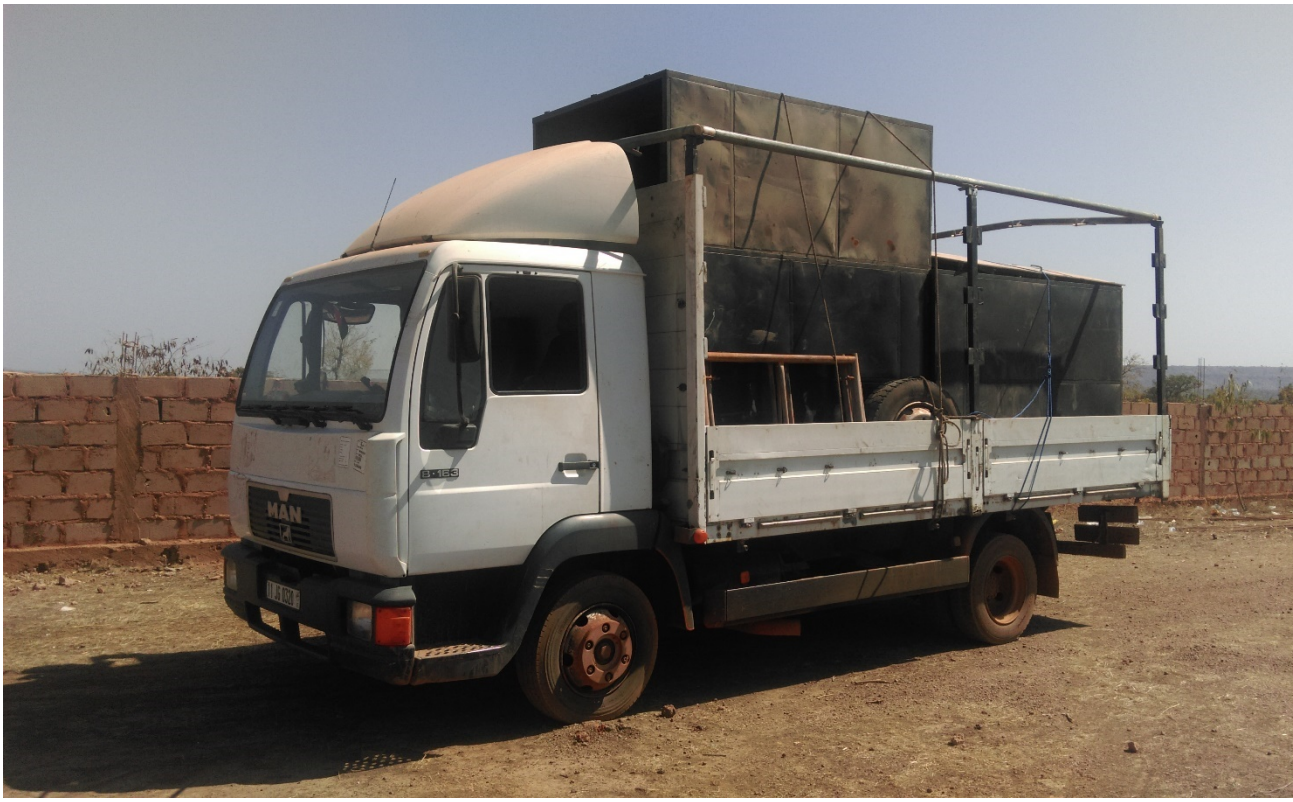
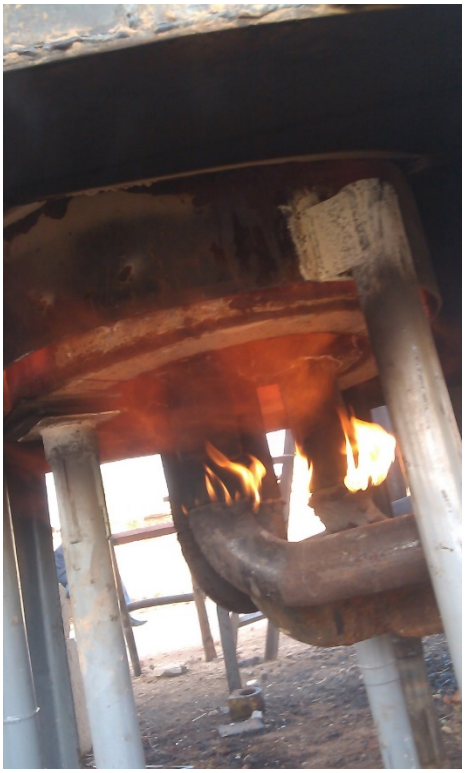
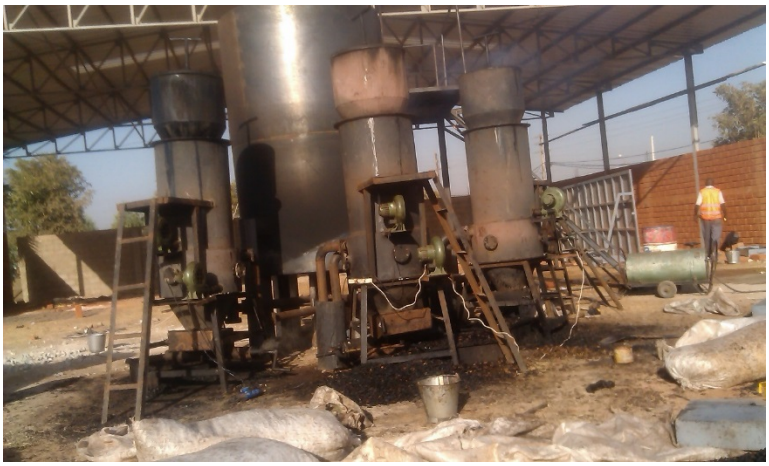


Figure 25 Transport of rice dryers

Visit to COWEMI

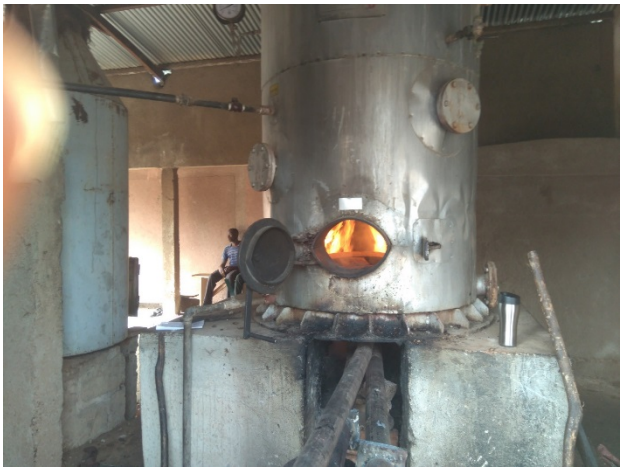
Quicklime production at COWEMI resulting in their visit at Tere-dia

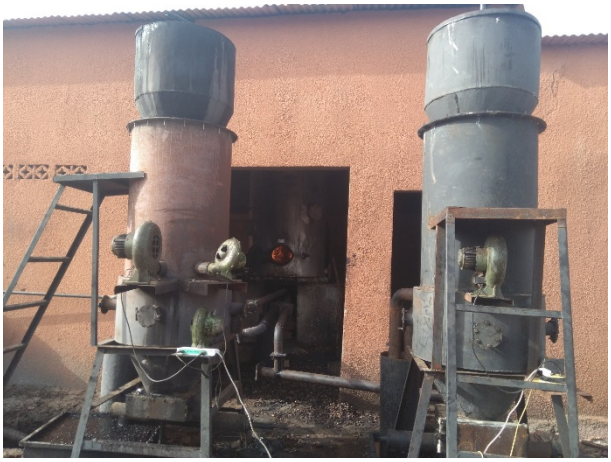




Visit to WOUOL

Cashew nut production at Wouol resulting in visit at Tere dia





Annex 2 Rural service concept

Rural service business model:

Take the case of Abdoulaye who is a rice producer:

At harvest the selling price of paddy rice can go down to 125 f CFA/kg. But Abdoulaye must sell because he loans for inputs and must repay. Also some pressing needs of the family have been postponed to the harvest and must be solved. So Abdoulaye has no choice but to sell his rice at a very low price, and it is not profitable enough for him.

Now Abdoulaye has a green growth platform instrument nearby. He goes to this service provider and uses his paddy rice in as a warranty. He receives 50% of the rice value directly from the banking partner to meet his urgent needs.

Abdoulaye must pay 500F per bag of 100 kilos per month of guarding. Which means that 3 months later, when the kilo of paddy rice will cost 160 F CFA.
The selling price per bag would be: 16000 F CFA
The costs of Warranty: 1500 F CFA
The income is therefore: 14 500 F CFA
Abdoulaye would earn 2000 F CFA more per bag, after deduction of the warranty fees. This equals to EUR 3.

But the concept does not stop at that. We also have the processing part.

Abdoulaye decides to sell his processed rice. So he goes to get a customer with his warehouse receipt document. The customer is convinced of the final product because the document comes from the partners of the warranty, which are reliable. The document informs about the quantity and quality of the rice. Also the customer knows that the factory that will transform the product does a good job because it has the right equipment and is managed by specialists.

Then the customer decides to buy the transformed rice of Abdoulaye. The latter goes to see the bank that orders the transformation to the processing unit. The customer takes his product back and pays the bank the agreed price. The bank then makes the distributions as agreed between it, the processing unit and Abdoulaye.

The 100 kilo bag has a 70% yield after processing.

Sold at 400 a kilo of rice, the bag brings in 28,000 FCFA
If we deduce:
1500 warrantee cost,
2500 processing cost per bag, including packaging
1000 CFA of ancillary fees for the bank

Then the sack of rice would bring 23,000 F CFA to Abdoulaye, an increase of 10,500 F (+ 84%) compared to the current situation, This equals to EUR 35.

We also note that if the unit transforms 10 tons of rice per day, it will make an annual turnover (300 days) of 105,000,000 FCFA. This equals to EUR 160,000.

The product of Abdoulaye is a non-perishable commodity in the short term. Same model can be used for other crops.