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Documentation of Selected Outstanding Innovations in Nigeria

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Summary

The GIC promotes four crops, namely Rice, in Nasarawa and Benue, Cassava in Ogun and Osun, Irish Potato in Plateau and Maize in Kaduna and Kano, respectively. The second round of PARI studies in 2016 were expected to find common ground with the GIC crops. This was implemented against the already documented results from Nigeria's 2015 PARI study 1 "An inventory of existing functional promising agricultural innovations in Nigeria".

The salient results from this study are as follows: 116 technologies were identified nationally during the review period (2006-2014); the top 4 commodities associated with the highest number of proven beneficial technologies are Cassava (32; 27.4%) , maize (20; 17.1%), sorghum (11; 9.4%) and rice (10; 8.5%); at least 45 items were found to trigger the 116 agricultural technologies assembled. The strongest or most frequent triggers of innovation include yield improvement, resistance to pests and diseases, wide ecological adaptation, high quality cassava flour, HQCF, shorter time to maturity, drought resistance, seed or grain colour, malting quality and grain weight or size. In general, some triggers are cross-cutting while several others are commodity specific.

The foregoing highlights substantially guided the conduct of the supplementary PARI 2016 studies, at least the choice of commodities.

Cassava Mosaic Disease resistant varieties:

Main issues: Cassava is used both as food and industrial raw material in Nigeria. Poor yield and yield losses were experienced among producers due to prevalence of CMD. The traits possessed, which address location-specific constraints in cassava production, include: high fresh root yield, high quality of cassava products, such as cassava flour, high dry matter content and wide ecological adaptation. The inability to process cassava roots into flour means huge post-harvest loss and wastages. When cassava varieties possess wide ecological adaptation, scaling up and out is enhanced. Then, food becomes more abundant, household income increases and poverty decreases.

The partners were: The NRCRI Demonstration plot, the States ADPs, Farmers, NGOs, Universities, Field days, Out Stations, On-Farm Research (OFR), On-Farm Adaptive Research (OFAR), and Training Programmes for Rural Women.

Economic benefits: The estimated yield of cassava at farmers' level is 14.20 mt/ha over an average farm size of 1.25 ha. At an open market price of N45, 000 / MT, total variable cost of N133,221.68/ha the estimated Gross margin /ha averages N505,778.32, which suggest a return of N3.80 per Naira invested. Thus, cassava production is fairly profitable at the smallholder level. Potential fresh root yields of the varieties range from 25-29tons / hectare across the ecologies listed below

Scalability: South-Eastern states, South-Western states and Northern States.

Innovation Group ownership and sustenance of productive assets

Main issues: Farmers are too poor to individually acquire and maintain assets that enhance their production and productivities. Thus, farmers operated and lived in poverty and with low productivity.

Main partners: Under three phases of the National Fadama Development Project, farmers were organized into Fadama User group for accessing credit, purchase and maintenance of productive assets. The key partners in the funding and implementation of the Fadama Projects were the World Bank, Federal, state and local governments, finance institutions, service providers and the various FUAs.

Economic benefits: The project development Objective (PDO) was to sustainably increase the income of project beneficiaries, increase productivities and lower poverty. Available project evaluation reports showed that these indicators were substantially achieved.

Scalability: The concept of group ownership of assets began as pilot in 12 Fadama II states (funded by the World Bank) and 6 states funded by the AfDB, and later scaled up under Fadama III to all the 36 states and the FCT.

Innovation: e-wallet input distribution and linkage with private agro-processing outlets

Main issues: Prior to the policy reform tagged ATA, agricultural production suffered two setbacks, namely poor linkage of farmers with the private sector and huge corruption in the procurement and distribution of inputs, especially fertilizers. Fertilizer pricing and distribution were done on public budget. The exercise was a huge burden on public budget but hardly beneficial to the target farmers. Thus, the fertilizer distribution and subsidy program was ineffective on farm productivity, leading to rising smallholder poverty, low productivity and poor access to basic foodstuffs.

Partners: FIII AF was implemented as partnership among the World Bank, Federal Government and selected states to strengthen the gains of FIII using the ATA policy reform in respect of input distribution and linkage of farmers to the private sector.

Economic benefits: State-wide access to high yielding and early maturing varieties of Cassava, namely, TME 419, TMX 30572, TMX 30555; State-wide access to high yielding and early maturing varieties of rice, namely FARO 44, FARO 52, FARO 54, FARO 62, FARO 60, FARO 61, FARO 57, with FARO 44 and FARO 52 most preferred / distributed across target states; Productive assets acquired for cassava production by the production groups include Sprayer, wheelbarrow, cassava lifter and First Aid box; Productive assets acquired for rice production and post-harvest value addition by the relevant groups include Sprayer, water pump, generator (for water pump), milling machine, de-stoner, and thresher; Fertilizers, seeds and pesticides were accessed using the e-wallet approach proposed under the ATA.

Organizational arrangement for access to rice parboiling technology

Main issues: GEM parboiling technology is an improved parboiling technology initiated by AfricaRice in collaboration with National Cereals Research Institute Badeggi (NCRI) and National Agricultural Development Programme (NADP) for increase quantity and quality parboiled rice in Nigeria. GEM Technology was installed in the Nasarawa/Benue hub in April 2016.

Partners: Seed producers; Grain producers; Rice parboilers; Rice millers;Traders; Transporters; Wheelbarrow Pushers; Brokers (Middle men); Bank/Microfinance; Extensions; Researchers; NGOs; Policy makers; Shade owners; Firewood cutter; Firewood sellers; Charcoal sellers; Rice grain gleaner; Local media; Equipment supplier/maintainers; Dryers; Consumer.

Economic benefits: Women parboilers that use the GEM technology make an extra 200 USD on every ton of rice parboiled compared to parboilers using the traditional system; The GEM parboiling technology has higher output rate of up to 25 tons of milled rice per month of high quality (lighter and uniform color, absence of heat-damaged grains and impurities, low levels of broken fractions); The GEM parboiling technology reduces expenditure on firewood from 1.83 to 0.64 USD per 100kg of paddy parboiled; The GEM parboiling technology reduces the steaming time from about 60-90 min to 20-25 min per 100kg of paddy; Women who use the GEM parboiling technology indicate that they do not suffer from heat burns and other sickness especially those related to smoke exposure and poor hygiene and face less difficulty in lifting loads.

Introduction

The PARI program is the research program of the "ONE WORLD, NO HUNGER" initiative. The German Government promotes two-pronged approach to implement the programs in Africa under the OWNH aspiration: Green Innovation Centre (GIC)- - managed by GIZ and PARI - - managed by ZEF. The GIC promotes four crops, namely Rice, in Nasarawa and Benue, Cassava in Ogun and Osun, Irish Potato in Plateau and Maize in Kaduna and Kano, respectively. The second round of PARI studies in 2016 were expected to find common ground with the GIC crops. This was implemented against the already documented results from Nigeria's 2015 PARI study 1 "An inventory of existing functional promising agricultural innovations in Nigeria". The salient results from this study are as follows:

• 116 technologies were identified nationally during the review period (2006-2014);

• The top 4 commodities associated with the highest number of proven beneficial technologies are Cassava (32; 27.4%), maize (20; 17.1%), sorghum (11; 9.4%) and rice (10; 8.5%). These results closely reflect the national importance of the 4 crops. Cowpea came in the 5th spot with 9 proven technologies and 7.7% of the total (116) reported. Irish potato was associated with just 1 technology (0.9% of 116).

• At least 45 items were found to trigger the 116 agricultural technologies assembled. The strongest or most frequent triggers of innovation include yield improvement (101 occurrences), resistance to pests and diseases (43 occurrences), wide ecological adaptation (41 occurrences), high quality cassava flour, HQCF (28 occurrences), shorter time to maturity (51 occurrences), drought resistance (11 occurrences), seed or grain colour (5 occurrences), malting quality (5 occurrences) and grain weight or size (5 occurrences). In general, some triggers are cross-cutting while several others are commodity specific.

The foregoing highlights substantially guided the conduct of the supplementary PARI 2016 studies, at least the choice of commodities.

Outstanding Innovations within GIC Commodities

Innovation: Cassava Mosaic Disease resistant varieties

Table 1 shows highlights relating to Cassava varieties that possesses traits which enables high yields.

Table 1: Cassava Mosaic Disease resistant varieties

Heading	Sub-title	Description
Background	Issues	Cassava is used both as food and industrial raw material in Nigeria. Poor yield and yield losses were experienced among producers due to prevalence of CMD. The traits possessed, which addresses location-specific constraints in cassava production, include: a. high fresh root yield,

Heading	Sub-title	Description
		b. high quality of cassava products, such as cassava flour c. high dry matter content e. wide ecological adaptation
	Effect of issues on livelihood, etc.	Yield loses and poor yield essentially meant poor food supply, low availability of industrial raw material and poor income for farmers and families. The inability to process cassava roots into flour means huge post-harvest loss and wastages. When cassava varieties possess wide ecological adaptation, scaling up and out is enhanced. Then, food becomes more abundant, household income increases and poverty decreases.
Pathways to innovation	Generation	The NRCRI Demonstration plot, the States ADPs, Farmers, NGOs, Universities, Field days, Out Stations, On-Farm Research (OFR), On-Farm Adaptive Research (OFAR), Training Programmes for Rural Women. Participatory Tools or approach used in promoting the Innovation: The State ADPs, NRCRI Demonstration plots, Agric Research Outreach Centres (AROCs), Farmers group; NRCRI project farms. CMD resistant varieties belong to a larger family of 43 cassava varieties that was jointly bred by IITA and NRCRI.
	Partnerships	CMD resistant varieties were introduced in Abia and other states through the joint effort of IITA, NRCRI, ARCN and ADPs.
Innovation description	Category (technological, institutional and organization)	CMD .resistant varieties include NR8082, NR8083, TME 419, TME 98/0505 and TMS 30572. Innovation is technological.
	Benefits	These varieties have advantages of early maturity, high yield, easy peeling and CMD resistance. Ultimately, farmers, processors and society at large benefits.
Economic benefits	Quantitative	The estimated yield of cassava at farmers' level is 14.20 mt/ha over an average farm size of 1.25 ha. At an open market price of N45,000 / mt , total variable cost of N133,221.68/ha the estimated Gross margin /ha averages N505,778.32, which suggest a return of

Heading	Sub-title	Description
		N3.80 per Naira invested. Thus, cassava production is fairly profitable at the smallholder level. Potential fresh root yields of the varieties range from 25-29tons / hectare across the ecologies listed below
Scalability	Areas targeted	South-Eastern states includes: Abia, Akwa-Ibom, Anambra, Bayelsa, Cross River, Ebonyi, Enugu, Imo, Rivers NR 8082, NR 8083 TMS 30572, TMS 30555, TMS 4(2) 14 Nwugo South-Western states including Delta, Edo, Ekiti, Kwara, Lagos, Ogun, Ondo, OIsun, Oyo TIMS 30572, NR 8082, NR 8083 Northern States including Adamawa, Bauchi, Benue, Borno, Gombe, Jigawa, Kaduna, Katsina, Kebbi, Kogi, Nasarawa, Niger, Plateau, Sokoto, Taraba, Yobe, Zamfara, FCT. TMS 30572 4 (2) 1425 NR 8082, NR 8083
	Usual constraints	• limited access to credit; • high cost of fertilizer • limited access to CMD resistant varieties • high cost of labour • poor access of women to inputs • limited market for cassava roots Cassava processing challenges include (Udensi, 2011): • high cost of transporting roots • lack of post-harvest processing machines or equip

Innovation: Group ownership and sustenance of productive assets

Table 2 shows highlights relating to social capital formation for sustainable access to productive assets during the country-wide implementation of the Fadama III project in Nigeria. The innovation involved was both organizational and institutional.

Table 2: Social capital formation for sustainable access to productive assets

Heading	Sub-title	Description
Background	Issues	Farmers are too poor to individually acquire and maintain assets that enhance their production and productivities.
	Effect of issues on livelihood, etc.	Thus, farmers operated and lived in poverty and with low productivity.
Pathways to innovation	Partners	Under three phases of the National Fadama Dev Project, farmers were organized into Fadama User group for accessing credit, purchase and maintenance of productive assets. The key partners in the funding and implementation of the Fadama Projects were the World Bank, Federal, state and local governments, finance institutions, service providers and the various FUAs.
Innovation description	Category (technological, institutional and organization)	The innovation involved was organizational and institutional. Farmers were required to jointly pay for group assets as a group, using their counterpart contributions that was to be matched by the funds of the federal, state and local governments. Also, FUAs were required to set aside or save 10% of their net sales for the maintenance of their group-owned assets. This was targeted at the sustainability of such assets beyond the life of the Fadama project.
	Sustainability	The FUGs saved on the average less than 4% of their net sales, thus threatening their ability to sustain the maintenance of their respective assets
	Social acceptability	Based on social capital formation, widely embraced by members in each FUG
Economic benefits	Quantitative	The project development Objective (PDO) was to sustainably increase the income of project beneficiaries, increase productivities and lower poverty. Available project evaluation reports showed that these indicators were substantially achieved.
Scalability	Areas targeted	The concept of group ownership of assets began as pilot in 12 Fadama II states (funded by the World Bank) and 6 states funded by the AfDB, and later scaled up under Fadama III to all the 36 states and the FCT.

Heading	Sub-title	Description
	Likely constraints	Only 9 states out of 36 and FCT in the Fadama III project met the requirement of saving 10% or more of the replacement value of the assets in the group's possession. These states are Adamawa (17.4%), Bauchi (13.6%), Gombe (13.9%), Kogi (10.3%), Nasarawa (21.2%), Niger (14.2%), Lagos (10.2%), Ogun (21.9%), and Plateau (16.6%). The national average savings by the group was 4.3%. This directly threaten long-term sustainability of group asset ownership.

Innovation: e-wallet input distribution and linkage with private agro-processing outlets

Table 3 shows highlights relating to reform of input distribution and pricing policies during the country-wide implementation of the Agricultural Transformation Agenda in Nigeria, under the auspices of the Federal Ministry of Agriculture and Rural Development. The results reported in Table 3 were obtained during the extended implementation of Fadama III, tagged Fadama III AF (Additional Financing).

Table 3: Policy innovation for improved access to farm inputs

Heading	Sub-title	Description
Background	Issues	Prior to the policy reform tagged ATA, agricultural production suffered two setbacks, namely poor linkage of farmers with the private sector and huge corruption in the procurement and distribution of inputs, especially fertilizers.
	Effect of issues on livelihood, etc.	Fertilizer pricing and distribution were done on public budget. The exercise was a huge burden on public budget but hardly beneficial to the target farmers. Thus, the fertilizer distribution and subsidy program was ineffective on farm productivity, leading to rising smallholder poverty , low productivity and poor access to basic foodstuffs.
Pathways to innovation	Partners	FIII AF was implemented as partnership among the World Bank, Federal Government and selected states to strengthen the gains of FIII using the ATA policy reform in respect of input distribution and linkage of farmers to the private sector.

Heading	Sub-title	Description
Innovation description	Category (technological, institutional and organization)	The innovation is both policy reform and institutional and technological. The policy reform sought to grant farmers direct input access to farmers using the e-wallet system in which the input suppliers are the private sector. Technological because the inputs consists of yield-improvement inputs are involved (improved varieties, fertilizers, etc.). Institutional because finance institutions are integrated into the reform.
	Sustainability	Project evaluation reports have shown that farmers have embraced the ATA policy reforms in terms of procuring inputs from the private sector, selling outputs to private agro-processors and seeking loans as groups from finance agencies.
Economic benefits	Quantitative	• State-wide access to high yielding and early maturing varieties of Cassava, namely, TME 419, TMX 30572, TMX 30555; • State-wide access to high yielding and early maturing varieties of rice, namely FARO 44, FARO 52, FARO 54, FARO 62, FARO 60, FARO 61, FARO 57, with FARO 44 and FARO 52 most preferred / distributed across target states; • Productive assets acquired for cassava production by the production groups include Sprayer, wheelbarrow, cassava lifter and First Aid box; • Productive assets acquired for rice production and post-harvest value addition by the relevant groups include Sprayer, water pump, generator (for water pump), milling machine, de-stoner, and thresher; • Fertilizers, seeds and pesticides were accessed using the e-wallet approach proposed under the ATA.
Scalability	Areas targeted	Rice was scaled up in the states of Ebonyi, Osun, Lagos, Kano and Niger. Cassava was scaled up mainly in Kogi state

Heading	Sub-title	Description
	Likely constraints	The will of subsequent governments to embrace and continue the input access reforms;

Innovation: Grain quality enhancer, Energy efficient and durable Material (GEM)

Table 4 summarizes a recent attempt to introduce a rice parboiling technology among farmers in Benue and Nasarawa states in Nigeria.

Table 4: Organizational arrangement for access to rice parboiling technology

Heading	Sub-title	Description
Background	Issues	GEM parboiling technology is an improved parboiling technology initiated by AfricaRice in collaboration with National Cereals Research Institute Badeggi (NCRI) and National Agricultural Development Programme (NADP) for increase quantity and quality parboiled rice in Nigeria. GEM Technology was installed in Nasarawa/Benue hub in April 2016. Training on how to operate it started on May 2016, and handed to the innovation platform in order to ensure ownership. The technology was developed to reduce drudgery, the risk of heat burns and exposure to smoke by the operators who are mostly women.
	Effect of issues on livelihood, etc.	Heat burns; drudgery and inefficient rice processing prevailed prior to this innovation
Pathways to innovation	Partners	Input supplier; Seed producers; Grain producers; Rice parboilers; Rice millers;Traders Transporters; Wheelbarrow Pushers; Brokers (Middle men); Bank/Microfinance; Extensions; Researchers; NGOs; Policy makers; Shade owners; Firewood cutter; Firewood sellers; Charcoal sellers; Rice grain gleaner; Local media; Equipment supplier/maintainers; Dryers; Consumer
Innovation description	Category (technological, institutional and organization)	GEM parboiling technology combines the use of a uniform steam parboiler and an improved parboiling stove. When the quantity of paddy to be parboiled is more than 50kg per session, other components

Heading	Sub-title	Description
		(paddy soaking tank, laborsaving devices and improved drying surface) are required. The GEM parboiling technology is not only about the equipment but also the process. The science: The parboiler consists of a stainless steel mesh basket that sits on a support in a stainless steel tank. During steaming, boiling water in the tank produces vapor that steams the paddy in the mesh basket. The tank is closed by a tight fitting lid that reduces heat loss but the system is not pressurized. The paddy soaking tank is made from stainless tank with a false bottom, a water discharge point and a paddy discharge point. The labor saving devices are either a rotational hoist or a chain hoist system for paddy weights less than 50 kg or paddy weights between 50-100kg respectively. The improved drying surfaces are cemented floors that have a 5% slope and raised 50cm from the ground. These surfaces have walkways that prevent users from walking directly on the drying surfaces to reduce contamination. GEM parboiling technology can be tailor for small (20-300kg), medium (300-1000kg) and large (1000-3000kg) scale processors. The cost of the technology will depend on the components and the scale of operation.
Economic benefits	Quantitative	• Women parboilers that use the GEM technology make an extra 200 USD on every ton of rice parboiled compared to parboilers using the traditional system. • The GEM parboiling technology has higher output rate of up to 25 tons of milled rice per month of high quality (lighter and uniform color, absence of heat-damaged grains and impurities, low levels of broken fractions). • The GEM parboiling technology reduces expenditure on firewood from 1.83 to 0.64 USD per 100kg of paddy parboiled.

Heading	Sub-title	Description
		• The GEM parboiling technology reduces the steaming time from about 60-90 min to 20-25 min per 100kg of paddy. • Women who use the GEM parboiling technology indicate that they do not suffer from heat burns and other sickness especially those related to smoke exposure and poor hygiene and face less difficulty in lifting loads. • The internal rate of return (IRR) of the GEM parboiling technology is 70% compared to 14% for the traditional technology •
Scalability	Areas targeted	Benue and Nasarawa states ; Rain-fed and irrigated ecologies but profitability is higher in irrigated ecology due to reduced brown to black spots on paddy;
	Likely constraints	• Skill to operate the GEM technology; • Access to finance for acquisition of GEM technology

Conclusion

This study focused on two of the GIC commodities, namely rice and cassava in the identification and description of the main innovations associated with them.
Some of the issues that necessitated the innovations included low productivity, poor disease resistance, weak access to inputs and post-harvest labor drudgery.

Quantitative and qualitative evidence of benefits were indicated when actors along the cassava and rice value chains adopted the identified innovations, namely improved varieties, group ownership and maintenance of productive assets , rice parboilers and e-wallet access to input purchase. The benefits included improved crop yields, improved access to quality seeds, higher monetary margins per hectare, reduced labor drudgery, and successful horizontal scaling of seeds and productive assets.

We demonstrated that innovation development and scaling requires multi-stakeholder partnership, for maximum impact on the beneficiaries. For sustainability of the milestones recorded for each of the innovations identified, it is recommended to maintain the underlying funding, institutional arrangements and partnerships already put in place during the project activities.

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Appendices: Components of the GEM innovation

Plate1: Paddy soaking tanks in Bukan-Sidi-Lafia Rice Innovation Platform, Nasarawa State, Nigeria

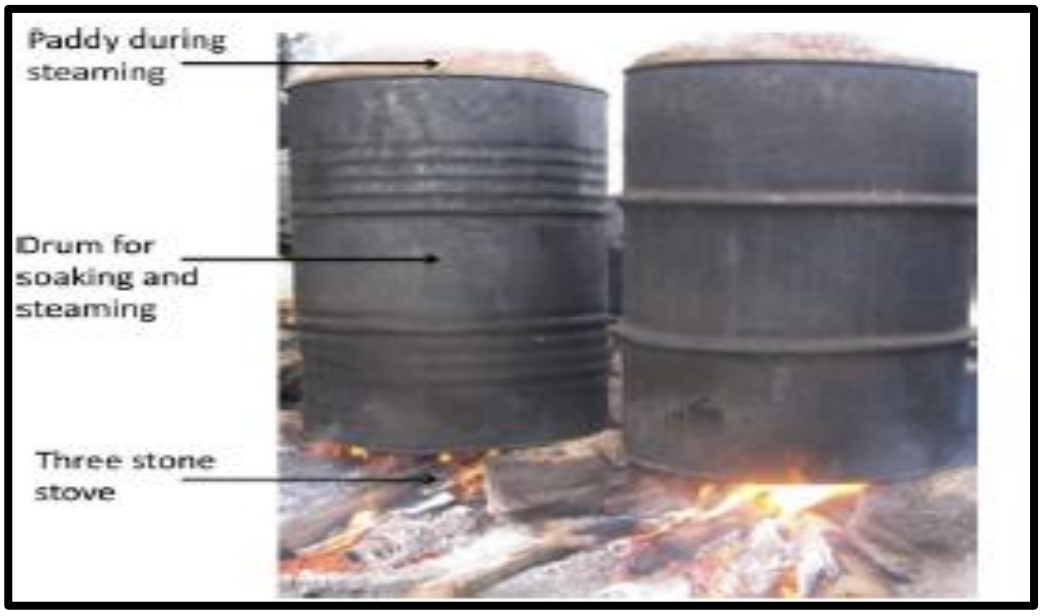

Plate 2: Traditional Parboiling Unit

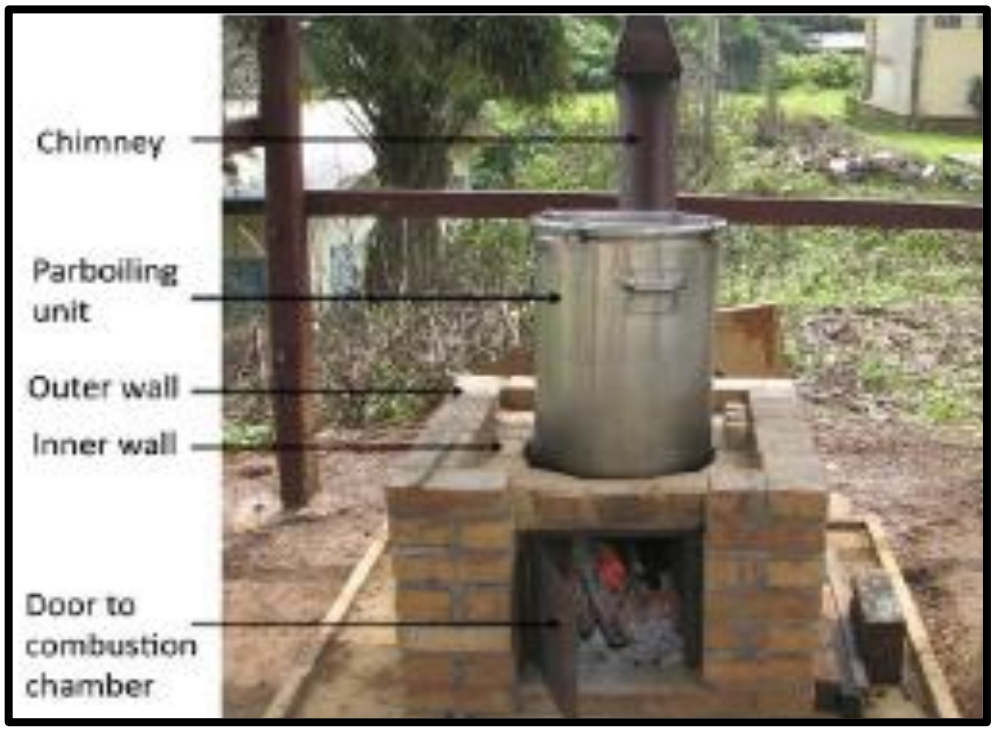

Plate 3: An Improved parboiling technology composed of an improved parboiling unit fitted directly on an improved stove made of fired bricks

Plate 4: An Improved parboiling unit at Bukan-Sidi-Lafia Rice Innovation Platform, Nasarawa State

Plate 5: Chain hoist system

Plate 6: Moisture Meter

Plate 7: De-stoning Machine

Plate 8: Improved drying surfaces with walk ways

Plate 9: Gender balanced stakeholders

Plate10: Bukan-Sidi-Lafia Rice Innovation Platform, Nasarawa State, Nigeria