19 Intellectual assets generated by AfricaRice under TAAT

1. Advanced Rice Varieties for Africa (ARICA) is a new generation of improved high-yielding rice varieties that poses genetic material which consistently out-yields other rice varieties available to farmers. ARICAs have been widely tested by the Africa-wide Rice Breeding Task Force in multi-location participatory varietal selection (PVS) across Africa, with the active participation of farmers. ARICAs came from lines developed by AfricaRice, CIAT, IRRI, and national agricultural research systems (NARS). A total of 18 ARICA varieties have been nominated as of April 2016: 5 ARICAs in 2013, 7 in 2014, and 6 in 2016.

Where piloted

ARICA was tested and or piloted in 30 African countries by the Africa-wide Rice Breeding Task Force using PVS. The current 18 ARICA varieties are available in Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Gambia, Ghana, Guinea Bissau, Mali, Nigeria and Uganda.

Number of farmers that technology was piloted with

Over 3000 farmers were involved in PVS for the 18 ARICA varieties.

Success factors

For a variety to be widely adopted by users, one of the most critical factors is that the variety should out-perform existing ones. The process of ARICA nomination through the Africa-wide

Rice Breeding Task Force ensures credibility for the descriptions of a new variety. The 18 ARICAs have been nominated based on particular advantages - iron toxicity tolerant; cold tolerant; salt tolerant; and good grain quality (high milling recovery, low chalky, short cooking time). ARICA 1, ARICA 2 and ARICA 3 respectively showed 20–44%, 50–111%, and 2–69% higher yield than NERICA-L 19 which is in wide use. However quality seed of ARICAs is the most crucial factor that constrains their wide-scale dissemination and adoption by farmers.

Benefits and impact on livelihoods at the pilot sites

Due to their better performance—high yield and stress tolerance—compared to the best rice varieties already cultivated by farmers, ARICA varieties will significantly increase productivity and contribute to improving farmers' livelihood in Africa.

Scalability

Although ARICAs, like the NERICAs, are highly scalable because farmers are involved in its testing across 30 countries in Africa, quality seed remains a challenge to widespread dissemination. Increasingly however, seeds of ARICAs are being multiplied and shared with national programs and NGOs in many African countries.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

The current ARICA varieties were selected in rainfed upland, rainfed lowland, irrigated lowland, high elevation (rainfed upland), and mangrove ecologies and are therefore suitable for these environments.

2 .New Rice for Africa (NERICA) variety is a generic name used for rice varieties developed from the interspecific crosses between Asian rice (*Oryza sativa*) and African rice (*O. glaberrima*) by AfricaRice. NERICAs are high yielding and are resistant to indigenous biotic and abiotic stresses.

Where piloted

NERICAs have been widely adopted by farmers in many parts of Africa. As of April 2016, 21 upland NERICAs are released and or adopted in 26 countries and 29 lowland varieties in 18 countries in Africa.

Number of farmers that technology was piloted with

NRICA varieties have already been widely cultivated. It is estimated that about 1.4 million ha with around 1 million farm households cultivated NERICAs in 2013.

Success factors

NERICA varieties have widely been adopted by farmers because of their good performance. For instance, the most popular upland NERICA variety, which is NERICA 4, has short duration (95–100 days), high yield (5 t/ha), drought tolerance and resistance to striga. The most popular lowland NERICA variety, NERICA-L 19 has high yields of 5–7 t/ha, is tolerant to iron toxicity, tolerant to drought and blast. Despite these successes, availability of quality seed of the NERICAs remains a bottleneck for its further widespread dissemination and adoption by farmers.

Benefits and impact on livelihoods at the pilot sites

The recent impact survey (data collected in 2013–2014) conducted in Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, The Gambia, Ghana, Madagascar, Mali, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania and Togo shows that on average, the adoption of NERICA reduces the poverty incidence (daily expenditure per person is less than $2) by 21%.

Scalability

The scalability of the NERICA varieties has already been demonstrated in Africa and this can be further enhanced through TAAT.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

The lowland NERICA varieties are suitable in both rainfed and irrigated lowlands while the upland NERICA varieties are for rainfed upland.

3. Sub1 rice varieties are climate-smart rice varieties that can withstand submergence/flood conditions. Currently, two sub1 varieties for West Africa and three varieties for Madagascar have been upgraded with sub1 gene through Marker-assisted-breeding. These varieties are similar to their original varieties but in addition, can tolerate submergence for a period of up to two weeks. In a flood situation non-usage of sub1 varieties can lead to total crop failure while Sub1 varieties can give 4 ton/ha paddy yield. This technology was very successful in Asia and has high potential to be successful in Africa also. Sub1 varieties are released in India, Nepal and Bangladesh. Around 5 million farmers are growing sub1 varieties in Asia. It is an important technology that can be deployed in flood-prone lowland areas in West Africa and in Madagascar.

Where piloted

Orissa, India (Reference: MH Dar, A de Janvry, K Emerick, D Raitzer & E Sadoulet, 2013. Flood-tolerant rice reduces yield variability and raises expected yield, differentially benefitting socially disadvantaged groups. Scientific Reports. 2013; 3: 3315. doi: 10.1038/srep03315)

Number of farmers that technology was piloted with

128 villages in total with 320 farmers having accessed the technology (see above reference)

Success factors

There is no other alternative technology available to farmers to mitigate the effects of flooding. Flooding for a duration of 7-14 days is needed to see the real benefit of the technology. Thus, identification of target domains through remote sensing and GIS is key for rapid and effective dissemination of this technology. This technology assumes more significance in the future as climate change is expected to increase the risk of flooding.

Benefits and impact on livelihoods at the pilot sites

46% increase in yields over the popular variety was observed when field are submerged for 10 days. In stress-free fields/years no penalty in yield was observed. Simulation shows 26.5% increase in rice production in the area if the variety was adopted. Marginal group of farmers benefitted the most. Adoption of this technology promoted the use of additional inputs by farmers.

Scalability

Technology is easily extendable to all submergence-prone areas. Seed multiplication and distribution are the main factors that determine scalability of this technology. International Centers such as AfricaRice, national agencies such as NCRI (in Nigeria) and private seed companies (Global Green in China) are involved in rice seed production. Their potential can be tapped to achieve full scale. Further, GIS maps for target countries like Nigeria are available which guides us where to target this technology.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Through remote sensing and GIS, target domain for this technology was identified in northern Nigeria. In TAAT initiative, before technology is introduced to new locations, target domain mapping will be conducted to make sure that technology will be effectively introduced.

4. Hybrid rice technology has indeed contributed significantly to food security and provided rural employment options in China for the last 30 years. Hybrid rice may have a yield advantage of 15–20% over an inbred rice variety. Therefore, hybrid rice occupied more than half of the whole rice area in China as of 2010. The interest of several AfricaRice member countries in hybrid rice encouraged AfricaRice to start breeding hybrid rice at the AfricaRice Saint Louis in Senegal in 2010.

Where piloted

Hybrids rice has been tested in Egypt, Mali, Nigeria, and Senegal. Testing is on-going in Gambia, Uganda, Burkina Faso, Mali, Nigeria, Senegal and Mauretania.

Number of farmers that technology was piloted with

About 100 framers were involved in the testing of hybrids in Mali, Nigeria and Senegal where this technology is quite new. In Egypt, more than 5000 farmers already cultivate hybrid rice.

Success factors

Hybrid rice has much higher yield potential than inbred rice; this is a major factor by which the technology may bring a success. Hybrid significantly contributed to food security in Asia, Latin America and Egypt, suggesting the technology may have high potential in Africa too. The most crucial factor to achieve success is the establishment of a specific seed system for hybrid rice in a country, at national programs, seed producers, and private seed enterprises level.

Benefits and impact on livelihoods at the pilot sites

Based on the evaluation in Mali, Nigeria and Senegal, hybrid rice will increase yield at least 1–1.5 t/ha, which brings income increase of US$200–300 per ha per growing season for farmers. Seed producers are also expected to have more income. The net benefit of hybrid seed producers ranged between 128–179% of that of the normal inbred seed producers. In addition, hybrid rice seed production will create employment opportunities in rural areas and young farmers could be new beneficiaries.

Scalability

Its scalability has already been demonstrated in Asia and Latin America, and in Africa in Egypt, more than 5000 farmers use the technology.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Irrigated and rainfed lowlands are suitable environments for hybrid rice. The hybrid rice developed by AfricaRice shows good performance under both normal and salinity condition, which is one of the major, rice production constraints in Sahelian countries.

5. RiceAdvice –This is a free android based application tool for providing farmers with guideline on field-specific crop management practices for rice to improve rice productivity and increase profitability. Farmers, extension workers, private rice sectors, and development agencies having smartphone or tablet with android device can use this app. To generate the guideline, farmers will answer questions in RiceAdvice regarding their rice growing environment, crop management, current yield level, etc. This interview will take 5-10 min. Also, RiceAdvice can identify best choice of fertilizers to be purchased based on nutrient requirement and fertilizer prices, and their amounts and application timing. Using RiceAdvice, farmers can also select their own target yield level based on their budget. It does not require internet connection to generate the guidelines in villages or fields, but it requires internet connection to update the app.

To further its improvement, AfricaRice is planning to incorporate outputs from crop simulation model “ORYZA2000”, and a tool for optimizing cropping systems for intensification “Cropping Calendar Construction (CCC) model” into RiceAdvice to provide farmers with precise information on crop duration, climate risk, and crop rotation options.

Where piloted

This tool has been tested in Burkina Faso, Ghana, Mali, Nigeria, and Senegal.Testing is on-going in Benin, Madagascar, Mauritania, Rwanda, Sierra Leone, Tanzania, and Togo.

Number of farmers that technology was piloted with
At the end of the year 2016, we will reach >15,000 farmers.

Success factors
As most of farmers do not have smartphone or tablets, service providers (e.g. public extension service, private service providers) are needed. After farmers receive guidelines, the service providers need to follow the guideline (e.g. fertilizer application amount and timing) to achieve farmers' specific goals in case farmers are not familiar with such guideline. Also, to have larger impact of use of RiceAdvice, farmers need to do good land preparation and crop management practices using improved varieties.

Benefits and impact on livelihoods at the pilot sites
Main beneficiaries are farmers. The use of this tool will increase paddy yield by 0.5-1 t/ha and bring profit margin increase of US$100-200 USD per ha per growing season. Other beneficiaries will be service providers, who gives guideline generated from RiceAdvice, and whom farmers could pay for their service (in case that they are from private sectors). The cost of service provision is under assessment.

Scalability
This technology can be scalable to all the irrigated lowland rice areas in sub-Saharan Africa, and relatively favorable rainfed lowland rice areas. Potential beneficiaries can be 3-4 million households with around 3-4 million ha of rice cultivation area.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Target domains are Irrigated lowland and favorable rainfed lowland where drought and flooding risk is small. Also, access to fertilizers should not be limited in areas of interest.

6. Good Agricultural Practices (GAP) is an integrated set of recommended crop, soil, water and weed management practices (Nhamo et al., 2014). GAP component technologies for rice may include, but not limited to practices such as: *animal or motorized traction for fine tillage; proper bunding and leveling of plots; use of improved varieties and certified seeds; sowing or transplanting in lines; application of judicious doses of composite fertilizers; application of soil and foliar micronutrients; application of fertilizer to the seedbed at crop establishment phase and placement in direct seeded rice; and optimally timed weed control using proper herbicide dosages followed by weeding with mechanical weeders* (Becker et al., 2003; Rodenburg and Johnson, 2009; Wopereis et al., 2007). Previous studies conducted by Africa Rice Center and its partners (Becker and Johnson, 2001; Haefele et al., 2000; Poussin et al., 2006) showed that the integration of different GAP component technologies adapted to local conditions can boost rice yields in a wide range conditions in Sub-Saharan Africa.

Where piloted

These technologies were piloted in Tanzania and in many West African countries.

Number of farmers involved in technology testing

There were 228 farmers involved in the technology testing for a period of three years in Tanzania.

Success factors

Integration of GAP component technologies should consider local rice-growing environment and socio-economic conditions. Farmer training and farmer-led dissemination with GAP is needed for successful adoption. Training materials such as 'GAP charts' developed by AfricaRice and its partners for specific rice growing conditions can be used to train farmers in large numbers.

Benefits and impact on livelihoods at the pilot sites

Integration of GAP component technologies can increase the rice yield by two to three-folds across sub-Saharan Africa. The maximum yield observed following GAP in Tanzania was 8.5 t ha^{-1} with a mean yield of 5 t ha^{-1} while the farmer's practice yields were at 2 t ha^{-1} (Senthilkumar et al, 2016). Similarly, increased yields were reported from farms across Africa where integrated GAP component technologies were followed: e.g., 7.8 t ha^{-1} in Benin (Tanaka et al., 2013) and 7.3 t ha^{-1} in Cote d'Ivoire (Becker and Johnson, 1999), 8.5 t ha^{-1} in Mauritania (Haefele et al., 2001) and even 9.0 t ha^{-1} in Senegal (Krupnik et al., 2012). Most GAP component technologies are gender sensitive and developed to reduce the labour requirement. For e.g. the mechanical and motorized weeders are set to reduce the labour time for weeding which will benefit the women and children the most.

Scalability

Integrated GAP component technologies can be designed to meet the requirement of each rice growing condition and local conditions. Hence, this technology can be scalable to all rice growing conditions in sub-Saharan Africa.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Integration of GAP component can be recommended to any domains. However, before out-scaling, local adaptation is needed for fine-tuning of component, which enhances adoption.

7. SMART-Valleys approach is a low-cost, participatory and sustainable approach to develop inland valleys for rice-based systems and follows a step-wise procedure focusing on design, lay-out and construction of low-cost water control infrastructure after a careful selection procedure paying attention to both socio-economic and biophysical factors and making extensive use of farmer knowledge. The approach starts with the identification of inland valley sites with potential for rice cultivation. This is done by a technical team working with farmers and village chiefs in the field. Key information needed include: importance of rice in the community, potential to grow, market price, suitability of the soil and water source for rice cropping, land tenure, etc. This information enables the technical team to discuss with communities that want to exploit the valley and those that are downstream and might be affected by the development. The design of the development is based on consultations with technical teams and farmers' knowledge and experience of water flow and retention on the soil surface. The design outlines the water intake, drains and bunds to enable greatly improved water retention in the valley lowlands and drainage of excess water from the valley. It may also include simple structures to divert water from a natural source and provide irrigation to thirsty rice fields when needed.

Where piloted

Benin and Togo

Number of farmers involved in technology testing

668 male and 818 female famers adopted SMART-Valleys in 2014.

Success factors

The *Smart-valleys* approach allows rice yields to double through improved water control, with only limited additional cost for the producers compared to common approaches high investment costs. *Smart-valleys* are low-cost and more sustainable because they are developed and constructed by the farmers themselves. Moreover, the approach can be implemented within one growing season. The approach creates ownership with the rice farmers and results in sustainable inland valleys development.

Benefits and impact on livelihoods at the pilot sites

In Benin, the gross margin of *Smart-valleys* famers was US$700 /ha, while that of control farmers was US$260 /ha. In Togo, the gross margins of *Smart-valleys* and control farmers were US$500 /ha and US$360 /ha.

Scalability

Any rainfed lowland with potential for rice cultivation. Training manual and video are available in French and English.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Mapping tool "Inland Valley Potential Mapper" has been developed by AfricaRice to identify suitable domains for development. In TAAT initiative, this tool will be used for first estimate of the potential for development.

8. Technologies for improved access and lifting of water for rice irrigation include a range of interventions which when used individually or in combination can help to improve availability and access of smallholder farmers to water for irrigation. They include technologies and tools for flood water diversion and control, improved water management in inland valleys, water storage (ranging from in-situ water conservation to on-farm tanks, ponds, small and medium-sized reservoirs), tapping groundwater and lifting water for irrigation using different types of motorized pumps, including fuel-, electric- and solar-powered pumps. Water made available through these technologies can be used for supplementary irrigation to bridge water deficit during dry spells in the rainy season or for full scale irrigation, especially in the dry season. These technologies can be used by smallholders individually or in communal groups and by medium- to large-scale farms managed by public and/or private sector agencies.

Where piloted

Due to time constraint, IWMI could not provide this info.

Number of farmers involved in technology testing

Due to time constraint, IWMI could not provide this info.

Success factors

Training and capacity building of farmer organizations, extension agents and NGOs serve to make the technologies more accessible to a wider range of farmers.

Benefits and impact on livelihoods at the pilot sites

These technologies lead to improved rice yields and income due to multiple cropping throughout the year. Irrigated rice yields can be expected to double or triple the average yield of 1.5 ton paddy per hectare obtained from rainfed rice production, with commensurate increase in income. Rice seed production in the dry season can also contribute to farm household income as returns to irrigated rice seed production are 5 to 10 times higher than returns to regular rice grain production. In the Sudano-Sahelian zone alone, water lifting technologies could allow up 10 million hectares to be irrigated for rice production.

Scalability

Inland valleys which cover approximately 190 million ha in sub-Saharan, of which less than 15% is currently being used (see http://www.africarice.org/publications/PLAR/techmanual/reference5.pdf, and http://awm-solutions.iwmi.org/inland-valleys.aspx); flood plains; areas with substantial reserves of groundwater and high potential for groundwater recharge (e.g. parts of the Sahel - Niger, Chad, Mali, Burkina Faso and Senegal – and Northern Nigeria).

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Mapping tools for irrigated rice area expansion in Africa have been developed to map the landscape and identify irrigated area, including spatial distribution of existing areas of irrigated agriculture, sources of water and crops grown. This tool will be updated and used in TAAT initiative (see http://www.iwmi.cgiar.org/2016/02/irrigated-africa-and-asia/).

9.Technologies for irrigation services and scheduling to improve field-level water management in rice fields includes ICT, Wetting Front Detectors (WFD), Alternate Wetting and Drying (AWD) technologies, system of rice intensification (SRI) practices and engineered irrigation surfaces (e.g. laser leveling and grading, graded furrows and graded border strips) that can be used to schedule irrigation and provide better water management through improved productivity and energy savings at the field level. These technologies work to better control, manage and reduce irrigation water use without decreasing rice yield.

Where piloted

The use of ICT in scheduling irrigation has been successfully proven by IWMI and partners in Sudan, while WFD technology has been extensively tested in Tanzania, Ethiopia, Ghana and Mozambique. AWD and SRI have been proven in Senegal, Egypt, Kenya, India, Pakistan, Sri Lanka and China.

Number of farmers involved in technology testing

Due to time constraint, IWMI could not provide this info. AfricaRice is testing AWD in Senegal involved with 15 farmers in 2016. >100 farmers visited AWD fields in field day.

Success factors

Training and capacity building for service providers (extension agents, land leveling contractors) is important when implementing these technologies to ensure efficient water management and distribution. Similarly, training and capacity building for smallholder farmers and extensions agents will be needed to improve the ability of men and women farmers in particular to install, use and maintain WFDs.

Benefits and impact on livelihoods at the pilot sites

Water savings and increased water use efficiency have been reported in projects and areas where WFDs have been deployed, for example, in the LIVES project implemented by IWMI in Ethiopia. Additionally, reduced diesel-power pumping due to timely scheduling resulted in savings of US$ 50-150 per ha, depending on water source. Continuous and sustained use of AWD and SRI by more than 80% of farmers after 3 years of adopting these technologies point to their usefulness in a wide range of agro-ecological conditions where they have been adopted.

In Senegal, the adoption of the AWD contributes to 20% irrigation water saving, increase in irrigation water productivity, and even a substantial increase in rice grain yield when well managed under good agricultural practices. There is reduction in pumping duration and an increase in energy efficiency.

Scalability

These technologies are applicable for paddy production or alternate wetting –drying systems on small, medium and large-scale irrigated farms. WFD can be adapted for supplementary irrigation in upland rice fields and for saving water on rice fields that depend mainly on surface water irrigation. AWD and SRI will work well in areas with engineered irrigation surfaces.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Depending on local water conditions (e.g. ground water level), best suitable water management options needs to be introduced.

10. Mechanical weeders are hand-operated devices that allow quick and efficient weeding of line-sown or line-transplanted rice. A mechanical weeders can cut, uproot and bury weeds by push-pulling it in between the rows of the crop. It should be followed by hand weeding of remaining weeds in the row. There are many different types of lowland weeders available (see: http://www.ricehub.org/RT/weeds/weeders/).

Where piloted

Participatory weeder selection was conducted in Benin, Burkina Faso, Côte d'Ivoire, Niger, Nigeria, Rwanda, Togo and Cameroon to identify best suitable weeders. Weeder out-scaling is undertaken in Benin and Nigeria.

Number of farmers involved in technology testing

Around 400 farmers were involved in participatory weeder selection. Pilot dissemination started in Benin and Nigeria with 200 farmers receiving the ring hoe weeders and used them in their fields. More than 95% of farmers want to continuously use them.

Success factors

Participatory weeder selection is needed to identify best suitable weeder for target domains.

They work mainly in line-sown or line-transplanted rice fields. Thus, farmers need to adopt such practices for introduction of weeders to farmers. Local private artisan fabricators should be trained, so that they can produce them and sell to farmers.

Benefits and impact on livelihoods at the pilot sites

The straight-spike floating weeder reduced weeding time by 32 to 49% and the twisted-spike floating weeder reduced weeding time by 32 to 56%, compared to hand weeding with similar weed control efficacy (Rodenburg et al., 2015). As hand-weeding in rice is mainly done by women and children, the introduction of mechanical weeders will likely play a major role in improving women's and children's lives in rural areas in Africa. The estimated timesaving of 32 to 56% will have a positive impact on the whole household.

Scalability

Mechanical weeders are suitable for all rice growing environments as long as the crop is sown or transplanted in equal-spaced lines.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

In a farmer-participatory study carried out in Benin where 6 different weeders were tested, the floater-less ring hoe tended to be preferred in non-flooded fields. Under flooded conditions, farmers liked both weeders with and without floaters (Gongotchame et al., 2014).

11. Motorized weeders can reduce labor inputs for weeding, and are engine-operated machines that allow quick and efficient weeding of line-sown or line-transplanted rice in irrigated lowlands. A motorized weeder can cut, uproot and burry weeds by walking it through the crop, in between the rows of the crop. It should be followed by hand weeding of remaining weeds in the row. There are different models of motorized lowland weeders available, fabricated in China, India or Japan and one locally fabricated one in Tanzania. Crop losses from weeds in rice are conservatively estimated to cost African economies around $1.5 billion per year, excluding costs of weed management. Hand-weeding is taking the lion share of all the labor required to produce rice.

Where piloted

The motorized weeders are piloted in four sites in Tanzania: Mbeya (Mbarali District), Kilimanjaro (Moshi Rural District), and Morogoro (Kilombero District and Mvomero District).

Number of farmers that technology was piloted with

During two seasons, the technology was piloted with 120 farmers (30 at each site).

Success factors

Locally fabricated prototypes and/or technical drawings should be available for local engineers to make it. The availability of two-stroke engines is also a necessity to fabricate these machines locally.

Benefits and impact on livelihoods at the pilot sites

Timesaving obtained with the motorized weeder compared to hand weeding is estimated to be around 90%. Weeding of rice in Africa is primarily done by women and children. Therefore, any technology making weeding less cumbersome and time-consuming will benefit them. As agricultural machinery is mainly operated by men, it is likely that the introduction of a motorized weeder, for instance as a community-owned implement, will completely liberate women from this task.

Scalability

The motorized weeder can be broadly applied in irrigated lowland rice across agro-ecological zones in Africa. Once private sector enterprises are trained in their fabrication and engines are locally available, they can be made locally. The technology should be promoted to private agricultural machinery fabricators and dealers.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

The motorized weeder is most effective in leveled and flooded fields, hence in irrigated lowlands. Another requirement is that the crop is sown or planted in reasonably weed and equal-spaced rows.

12. Axial Flow Thresher (ASI) – Threshing of rice involves the separation of the paddy grain from the rest of the cut plant. The ASI thresher-cleaner which is suited to conditions of manual harvesting, has high threshing capacity, low fuel costs, and can be manufactured locally. Private artisan blacksmiths and farmers have been trained in the manufacturing and operation of ASI. This thresher-cleaner can greatly decrease labor costs and reduce the amount of the grueling labor that rice threshing requires. ASI uses a diesel engine of 12-14 hp with an oil bath air filter. Its fuel consumption is low (2 liters per hour) in comparison to other similar threshers. For a high output level, four laborers and two operators are needed. ASI can thresh 6-7 t of paddy rice per day, much more than another commonly used thresher. It can result in grain-straw separation rate of 99%. ASI both threshes and cleans the grain, resulting in grain that needs no winnowing and can be bagged directly from the machine.

Where piloted

19 countries consisting of Nigeria, Mauritania, Gabon, Cameroun, Uganda, Guinee Bissau, Gabon, Bénin, Madagascar, Mali, Tanzania, Burkina faso ,Cote D'Ivoire ,Niger, Gambia ,Senegal, Ghana, Ethiopia, Sierra Leone.

Number of farmers involved in technology testing

132 partners received the threshers (local private artisans, institutions, governments). 108 total artisans trained to build the thresher.

Success factors

Public awareness, training in manufacturing, business plan, and access to financial services are needed to scale out ASI. Service providers are needed in situations where farmers cannot buy it. Another option is purchasing at community level. Local development efforts, conducted in collaboration with local blacksmiths and artisans, are needed to adapt types that are suited to the local growing and harvesting condition.

Benefits and impact on livelihoods at the pilot sites

Farmers (who do not have own thresher) can save time, reduce labor demand, reduce grain loss, and enhance double cropping. ASI owners can expect an internal rate of return of 65% and a high cost: benefit ratio (1.73) over the economic life of ASI. Local blacksmiths' income can be increased. Employment for providing service for threshing can be increased. Indirectly, Governments can get taxes on the importation of the engine, belts and bearing. Banks may be encouraged to provide with loans to farmers and owner of ASI.

Scalability

All zones with rice production. The mini ASI thresher is a gender-friendly tool, and can be used by women. The thresher is considered as a multiple crop thresher, and can be used to thresh paddy rice, wheat, cowpea, sorghum, and millet.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

Most suitable areas for introduction of this technology are large irrigation schemes where double cropping is common and yield is high such as Senegal River Valley.

13. The GEM parboiling technology is an improved parboiling technology called grain quality-enhancer, energy efficient and durable material (GEM) parboiling technology and combines the use of a uniform steam parboiler and an improved parboiling stove. The GEM parboiling technology is not only about the equipment but also the process. The parboiler consists of a stainless steel mesh basket that sits on a support in a stainless steel tank. The paddy soaking tank is made from stainless tank with a false bottom, a water discharge point and a paddy discharge point. The stove is an improved rocket stove made of baked clay bricks with special ventilation. The laborsaving 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. The GEM 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.

Where piloted

The GEM has been piloted in Glazoue, Malanville rice hubs in Benin and Nassarawa/Benue rice hubs in Nigeria. Plans are underway for Niger and Sierra Leone.

Number of farmers (parboilers) involved in technology testing

The technology has been piloted with a total of 2,265 rice processors.

Success factors

Increase profit margin of US$200 on every tonne of rice parboiled compared to parboilers using the traditional system; increase quantity and quality – GEM has higher output rate of up to 25 tonne of milled rice per month of high quality; decrease fuel consumption – GEM reduces expenditure on firewood from US$ 1.83 to US$ 0.64 per 100kg of paddy parboiled; gain in time – GEM reduces the steaming time from about 60 - 90 min to 20 - 25 min per 100kg of paddy.

Benefits and impact on livelihoods at the pilot site

In the Malanville innovation platforms (IP) in Benin for example, 25 tonne of quality milled rice was processed by women rice parboilers within four months of using the GEM technology. Additional benefits include – increase sale of paddy especially amongst producers who sell in large quantities (> 1 ton) at once; increase commercialization of locally produced milled parboiled rice; increase revenue of parboilers using the GEM technology; increase acceptability of locally produced rice using the GEM by urban consumers.

Scalability

The GEM technology can be constructed at the village level in any African country. Private local artisans and builders who have the drawings or a sample copy can acquire the materials and build the technology. However, rice parboilers will have to be trained on how to use the technology to produce high quality rice.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

The GEM technology is recommended for rice parboiling and any other cooking process that requires steaming such as the pasteurization of fruits and cereal juice. Irrigated and lowland rice ecologies will record higher rate of return than upland ecologies.

14. Biomass Gasification Technology – the biomass gasification technology at AfricaRice employs top-lit updraft gasifiers (stoves) for the generation of thermal energy from agricultural residue for household, restaurant and small scale food processing industries. These gasifiers use a solar battery powered 12 volt fan to prompt air necessary for the gasification process to be efficient. These gasifiers have been tested and shown to burn efficiently with the following agricultural residues as fuel: rice husk, rice husk mixed with palm nut shell, rice husk pellets, and groundnut shells. Other fuels with similar characteristics to those mentioned above are also expected to be gasified efficiently by these stoves to produce clean thermal energy.

Where piloted

The AfricaRice MV and MPO gasifiers have been piloted in Benin and Cote d'Ivoire.

Number of Actors technology has been piloted with

AfricaRice MV and MPO gasifiers been piloted with 10 women from Benin and 15 artisans from Cote d'Ivoire.

Success factors

Gasifier running on husk or husk mixed with palm nut shell cook faster than other stoves using wood or charcoal; decrease smoke and emissions – gasifiers produces very little smoke and low emissions compared to wood stoves; decrease biomass consumption – the specific fuel consumption (g/liter of water boiled) of gasifiers is low compared to other stoves.

Benefits and impact on livelihoods at the pilot site
Decrease dependence on traditional wood and fossil fuels of fuel for cooking; decrease cost of wood fuel for cooking for households in the vicinity (< 200 m) of rice milling facilities with a turnover of least 1 ton paddy/day. This quantity of paddy can serve a minimum of 30 household per day; and decease land and air pollution around rice milling facilities due to abandoned or slow burning rice husk.

Scalability
AfricaRice MPO and MV gasifiers can be simple constructed at village level in any African country. Local artisans who have the drawings or sample copy can acquire the materials and build the technology. In addition, end-user will have to be trained on how to operate the technology.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to
The gasifiers are suitable for household cooking in many households and under various conditions.

15. Fortified Rice-Wheat Composite (FRWC) Biscuits are of two different types. One is made from up to 60 % rice-wheat composite flours and fortified with safou (Dacryodes edulis) and this product is for safou consuming areas in Africa, while the other is made from up to 60 % rice-wheat composite flours fortified with vitamins [Rice Powder Premix (WE-26446), The WrightGroup, USA]. A safou-fortified biscuit provides mainly minerals (magnesium, potassium, iron, zinc) and essential lipid (linoleic acid) while a vitamin-fortified biscuit provides vitamins (folic acid, thiamin, niacin, cobalamin, vitamin E) and minerals (selenium and zinc).

Where piloted

This technology has been piloted in Yaoundé, Garoua and Ndop Cameroon. This technology has been piloted with 110 women in Cameroon.

Success factors

Processors mostly women who use rice-wheat combination make an extra US$ 0.16 per Kg of flour used for baking compared to those who use wheat flour only. Millers also made a profit of US$0.08 per kg off broken rice after processing into flour. Broken rice sells at US$ 0.6 per kg while rice flour produced from the same rice sells at US$ 0.8/kg which is comparable to the price of high quality milled rice in the region.

Benefits and impact on livelihoods at the pilot site

Reduction in malnutrition related to nutrient deficiency especially in children, as well as increase consumption of locally produced rice.

Scalability

The technology can be scaled through training on fortification of rice-wheat flour and production of biscuits. However, beneficiary will need to acquire equipment for flour mixing (to uniformly mix premixes with the entire flour) and baking (dough mixer, dough dispensers and baking oven).

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to
This technology is suitable for all rice consuming households in the various growing ecologies.

16. Mineral and vitamin fortified rice and rice products – rice is basically a carbohydrate food because 90% of a milled rice grain is composed of starch with small amounts of fats and proteins. The mineral and vitamin content of milled rice is almost negligible making populations that predominantly consume rice prone to micronutrient deficiencies. Technologies developed by the Wright Group (a principal partner of AfricaRice) are able to coat (fortify) rice grains with any combination of minerals and vitamin according to the nutritional requirement of the target population. The fortified grains are mixed with "normal" rice grains at a ratio of not more than 1% to produce a product with the recommended daily intake (RDI) of the micronutrients by the population. The technology is also rinse-resistant and over 90% of the micronutrients remain after cooking. With this technology, every rice variety can be nutritionally enhanced before consumption. The fortified rice could further be processed into infant foods, biscuits and other baked products.
Where piloted
These products have been piloted in the Philippines, Costa Rica and Ghana. In each of these countries, milled rice grains and

flour were fortified with different levels of minerals and vitamins according to the requirements of the target communities.

Number of beneficiaries that technology was piloted with
Technology was piloted with 2,000 people in the Philippines, 350 in Costa Rica and 125 in Ghana.

Success factors
Levels of anemia in children particularly who consumed the iron-fortified rice products improved during the 6 month test period.

Benefits and impact on livelihoods at the pilot sites
The effect of stunting and disguised malnutrition is incalculable in many African countries. The learning abilities of children with micronutrient deficiencies are compromised and children born to malnourished mothers are bound to have learning and developmental defects. The consumption of fortified rice and products in vulnerable pilot communities went a long way in alleviating these effects on the populations.

Scalability
Most of the "nutrition" in the bio-fortified rice is in the bran layers that are polished away during milling. This technology apart from being widely acceptable has most of the added minerals and vitamin available to the consumer. The cost of the technology is cheap and will not add more than US$ 0.15 to the cost of a kilo of normal rice. A price which is negligible

compared to the nutritional benefits it brings to the consumers. Additionally 90% of the added minerals and vitamins are retained after cooking.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to
This technology can basically be applied across all the cereal value chains of TAAT and more particularly in major rice consuming communities in rural and peri-urban areas.

17. Rice-based (gluten free) pasta is a very popular food globally with a high market value. This product is however made from durum wheat which is largely not grown in Africa making pasta a food product that is likely to be imported into Africa because of its popularity. A number of people are also allergic to the wheat protein, gluten and such people cannot eat regular pasta. Technologies developed by AfricaRice and partners from the University of Milan in Italy have resulted in the production of high quality pasta from rice varieties grown in Africa. This technology provides an important and high value end product for chalky and lower grade rice which would otherwise have attracted a lower market price on local markets. The grains are parboiled, ground or granulated into pellets and extruded to produce pasta. This pasta can also be fortified with minerals and vitamins to the requirements of the local target populations. This technology has the potential of providing a viable avenue for the transformation of lower grade rice into a product that has great nutritional advantage as well as a high market value. This product requires that the paddy be parboiled with high heat intensity to obtain a high degree of gelatinization.

Where piloted

The production of the product is piloted in Benin and Ghana

Number of consumers that technology was piloted with

40 rice consumers tasted and evaluated the product in Benin and Ghana

Success factors

This would provide a market for regular producers of parboiled rice in the communities. Persons with gluten intolerance can also eat pasta with minimal health risks.

Benefits and impact on livelihoods at the pilot sites

This product can be consumed by all persons and it is particularly suited for populations with gluten intolerance conditions. It will also have a market in urban areas where most of the imported pasta is consumed in many African countries. The effect of processing large volumes of locally produced rice into a high value end product such as pasta has the potential of significantly increasing the incomes of those who take it up and this will consequently have a positive effect on their livelihoods. Allied employment can be enhanced with the increased demand for locally parboiled rice which is the intermediate product for rice pasta production.

Scalability

The main target consumers of the product would be the general population but the production of the intermediate product, that is, parboiled rice is mainly carried out by women. Also most of the vendors of rice and rice products in Africa are women who will further benefit. The processes of producing the rice based pasta are flexible such that any food processing entrepreneur irrespective of gender can take it up.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

This technology will find ready usage in the major rice parboiling and milling value chains under the TAAT initiative. The effect of this on rice consumers in major cities under the TAAT initiative will also be significant.

18. Marketing strategies (MS) comprise marketing actions and methods dedicated to yield larger sales of products in competitive urban and niche markets in order to achieve maximum profit and sustain the business. The MS have strong links with grain quality upgrading and breeding strategies in terms of improvement of existing products or development of new products. The MS (actions) in rice business consists of: (i) creating an image with an accurate informant label, an attractive brand and packaging to differentiate products from its competitors and convince consumers of its quality; (ii) making more visible the products in marketing channels; and (iii) promoting through marketing campaign to increase consumer awareness. The MS (method) combines tool and approaches to identify segments of markets and consumers' preferences and the price premium they want to pay for the preferred products.

Where piloted

The marketing actions have been implemented in Benin and Senegal. The improved rice products have been promoted in Benin and Kenya through trade fairs and exhibitions. An inclusive method supporting grain quality improvement has been deployed in Benin, Cote d'Ivoire, Madagascar, Mozambique, Niger, Nigeria, Senegal, Tanzania and Uganda to elicit more than 1320 urban consumers' willingness to pay for their preferred attributes in rice products.

Number of farmers that technology was piloted with:

More than 10,000 farmers involved in rice innovation platforms (IPs) have been positively impacted by the MS because an increase of the sales of products impacts directly their farming business.

Success factors

Permanent availability of high quality paddy to be used to produce high standardized quality milled rice products using improved processing technologies is needed. Once this is done, the marketing action can be deployed to create an image for the products and make it more visible through marketing channels with the support of marketing campaign, trade and innovation fairs.

Benefits and impact on livelihoods at the pilot sites,
Implementation of MS has increased the sales of local produced rice about 90 - 173% and its visibility in urban markets. High price premium for products was revealed to be positively correlated with the products properly processed.

Scalability
Marketing strategies can be scalable to all rice products and rice-based products produced or to be produced in processing plants in IPs in order to marketing larger volumes of high standardized quality rice products in urban and niche markets.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology/innovations could be applied to
Target domains are IPs where improved rice processing plants are installed with commitment to produce high standardized quality rice products and rice-based products responding to the needs and preferences of consumers, especially urban consumers.

19. Innovation platforms (IP) is a tool to help identify value chain actors, examine bottlenecks and weak links in the value chain, build and strengthen partnerships and collaborative learning among actors (both public and private), and address business opportunities and new products for improving market outcomes, food security and natural resource management.

Where piloted

To date, 12 IPs have been established by AfricaRice in select rice sector development hubs of 8 countries in Africa (Benin, Cote d'Ivoire, Ghana, Sierra Leone, Niger, Nigeria, Uganda and Madagascar).

Number of farmers that technology was piloted with

The IPs have been piloted with over 4000 farming households (21% women) and over 2000 rice processors (80% women). Members of the IPs also include input dealers, extension, seed enterprises, transporters, financial institutions, researchers, NGOs, and policy makers among others.

Success factors

Farmers and agro-food product processors form the core of the IP and show ownership; IP farmers have access to high-yielding and stress-tolerant varieties/hybrids and inputs; self-organized farmer groups each cultivate 0.25 - 1.0 ha of improved varieties/hybrids; locally based agro-food processors and transporters are actively involved; local and regional market opportunities allow the production and sale of quality seeds, paddy, grain, and locally processed agro-food products; skilled IP facilitators and active champions of change in the IPs; extension and NGOs provides advisory services and research provides technical know-how; robust policy engagement, incentive regimes, and confidence and trust building is carried out at various levels of the stakeholders; competence and skills enhancement of IP actors; enhanced access to information and knowledge; adult education to improve literacy skills of IP actors, and clear roles and adaptation to unforeseen changes and new opportunities.

Benefits and impact on livelihoods at the pilot sites

The recently established Malanville IP in Benin processed over 25 tonne of paddy into good quality parboiled rice using the GEM rice parboiler technologies. This IP was awarded for the good quality rice grain that competes with imported brands. In Madagascar two IPs have produced 36 tonne of "Maromila" red rice and 68 tonne of NERICA 4. In Nigeria, the Nasarawa IP has expanded its membership to 21 primary cooperative members, with over 1000 rice processors who will be soon be using the installed GEM rice parboiling technology to enhance grain quality.

Scalability

IPs are a flexible and dynamic institutional innovation that can be adapted and applied in different contexts to address a range of value chain constraints and opportunities in rainfed upland, lowland, and irrigated rice ecologies.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

IPs are suitable for market oriented production systems, food security, and natural resource management. In rice it is used in rainfed upland, lowland, and irrigated ecologies.

Brief description of the technology/ innovation

Analysis with R is Simplified (ARiS) is a free tool for data, knowledge management and analysis and visualization for agricultural sector, and has user-friendly interface. It helps improving data management and quality, and facilitates data analysis for rice value chain actors in Africa. This will also help data management in the projects like TAAT initiative. As example, this technology includes following data management and statistical methods:

- Data management: Compute new variable using arithmetic or statistical function, Merge two or more datasets, Recode information into same variable or into different variables
- Descriptive statistics: Summaries, Frequencies
- bivariate statistics: Means, t-test, ANOVA, Correlation, Nonparametric tests
- Prediction for numerical outcomes: Linear Model, Generalized Linear Model - Logistic Regression, Probit Model, Multinomial Logistic Regression, Ordinal Logistic Regression, Ordinal Probit Regression
- Prediction for identifying groups: Factor analysis, Discriminant, cluster analysis
- Visualization: Scatter Plot, Bar Chart, Box Plots, Line Chart

Where piloted

ARiS was piloted in Benin, Senegal, Sierra Leone, and Madagascar

Number of persons that technology was piloted with

ARiS was piloted with around 80 persons

Success factors

Although ARiS is intuitive and easy to use, in-person training (coaching and mentoring) is needed to make sure that users will use this tool in right way in their business.

Benefits and impact on livelihoods at the pilot sites

ARiS is helping rice value chain actors including researchers in Benin, Senegal, Sierra Leone and Madagascar to effectively make use of data in the face of uncertainty and to derive maximum value on it. In addition, ARiS has tutorials with case studies, which is used to train stakeholders on how to generate information and knowledge from the agricultural sector to support decision taking.

Scalability

ARiS version 1.0.2 already includes features for making available information from the agricultural sector. Further versions will include more socio-economics and spatial aspects to better operate with trend analysis.

Scientifically determined recommendation domains as well as the TAAT value chains that the technology could be applied to

ARiS is suitable to support actors in the rice value chain in their information and knowledge management and analysis. Particularly for actors in Africa like development agencies, extension workers, private rice sectors, research institutes, and universities.