ENHANCED ACCESS TO CLIMATE-SMART AGRICULTURE AND CLIMATE INFORMATION SERVICES BY FARMERS IN MALI

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Activity report

CGIAR | AICCRA
Accelerating Impacts of CGIAR Climate Research for Africa

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List of abbreviation

AfricaRice	Africa Rice Center
AICCRA	Accelerating Impacts of CGIAR Climate Research for Africa
CIS	Climate Information Services
CSA	Climate Smart Agriculture
IER	Institute for Rural Economics
IV	Inland vallleys

Abstract

Mali is a rice basket in West Africa, providing a substantial amount of the region's rice supply, but is also highly vulnerable to climate variability and change. AICCRA-Mali aims to strengthen the technical, institutional, and human capacity required to accelerate the wide-scale adoption of climate-smart agriculture and climate information services packages by hundreds of thousands of men and women farmers in Mali. The project focuses on rice and associated speculations (legume, vegetable, tuber, fish, and tree) value chains and pursues to enhance resilience to drought and flooding in rainfed systems and cold and water scarcity in irrigated systems. In 2022, 111,064 farmers including 49% women were supported in the use of CSA and CIS interventions by AfricaRice and the national partners (Syngenta Foundation, Niger office, Mali-Meteo and IER). The focused CSA and CIS interventions were RiceAdvice, drought-tolerant rice varieties, alternate wetting and drying, mechanization services, solar-powered irrigation, GEM parboiling, direct seeding, and information about weather forecasts. The mechanisms used included service provision business models, technologies demonstration followed by farmers' exchange days, save-for-change financing mechanism, Pay-As-You-Go business model, multi-stakeholders' platforms, and Local Groups for Meteorological Assistance. Application of RiceAdvice recommendations improved rice yield by 0.9 t/ha and farmers' income by 320 USD/ha. The yield increase was higher in women's fields (+1.0 t/ha) compared to men's fields (+0.8 t/ha), which was attributed to the fact that women have culturally access to soils with lower fertility than men's in Mali, and consequently, the soil responses to applied fertilizers were better in women's than in men's fields. When the benefits of the use of RiceAdvice were aggregated over the total area cultivated by the 53,045 farmers, the rice production increase was estimated to be 42966 tones and the farmers' income increase was estimated to be 15.3 million USD. Farmers who used the solar-powered irrigation pumps increased their income by USD 5,262 per hectare, and improved their food consumption score by 3.1. The food consumption score is the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. The use of solar-powered irrigation technologies enabled farmers to produce cash crops such as onion, tomato, cabbage, and potato during the dry season when fields had previously been abandoned due to water scarcity. Thanks to these additional crops, the increase in their incomes mean they are investing more in quality seeds, and fertilizers.

1. Introduction

Mali is a rice bowl in West Africa, providing an important amount of regional rice production, but is also highly vulnerable to climate variability and change. Aside from temperature rises, changes in rainfall patterns, increase in the frequency of extreme events such as droughts and floods, desertification, and changes in disease vectors, were observed in Mali over the past decades. Projected decreases in rice yield as a consequence of climate change varied from 10 to 80% depending on the production system. To enhance the resilience of the rice sector to climate change, AICCRA-Mali used a participatory framework to prioritize climate-smart agriculture and climate information services, and identify the barriers, incentive mechanisms, and roles of institutions for ensuring large-scale adoption. The results showed the best bet interventions include RiceAdvice, drought, and submergence tolerant varieties, parboiling kit, solar-powered irrigation systems for supplemental irrigation, the system of rice intensification, direct seeder, and weather forecasts, while access to finance was identified as a major barrier for CSA and CIS adoption. Subsequently, Mali developed partnerships with key national organizations, organized training sessions, provided backstopping, and deployed inclusive business models to ensure large-scale adoption of the above-

mentioned CSA and CIS interventions. The description of the CSA and CIS interventions disseminated to farmers is presented in the following section.

2. Description of CSA and CIS interventions disseminated in 2022

2.1 RiceAdvice

Shifting planting dates and fertilizer application rates have the potential to mitigate the negative impacts of climate change on rice production. Therefore, efforts are being made by governments and development agencies to spur agricultural intensification and climate change adaptation through revised crop calendars and fertilizer recommendations. These endeavors, however, have been met with continued low levels of adoption partly because of the failure to account for the highly heterogeneous and local context. Unable to represent the complexity of actual farms, institutions produce standardized recommendations for crop calendar and the levels of input use, and the resulting development programs and policy "solutions" pay scant attention to the particularity of a given field or farmer, collapsing or ignoring distinctions that might otherwise be relevant. Although it was historically expensive to account for heterogeneity in fields and farms when producing recommendations, in the past few years, mobile technology in the form of decision support tools has greatly reduced the cost of delivering personalized advisory services. RiceAdvice is an Android-based application (or app) that was developed by AfricaRice to provide personalized recommendations on crop calendar, variety, and nutrient management (type, quantity, and timing of fertilizer) in rice production. The app utilizes information and communication technology (ICT) that enables extension agents to gather data from farmers about the particular local context. The app then provides farmers with the specific crop, field, and seasonal advice regarding crop calendar, variety, fertilizer application, and agro-management practices.

2.2 Drought and submergence-tolerant rice varieties

It is widely acknowledged that drought and submergence-tolerant rice varieties have the potential to enhance farmers' resilience to climate change. However, due to the limited availability of quality seeds, the adoption of drought and submergence-tolerant rice varieties has been limited in Mali. AICCRA-Mali established partnerships with the Institute for Rural Economics (IER) in the identification of the most preferred drought and submergence-tolerant rice varieties that meet farmers' and consumers' preferences and strengthened the capacity of the Center for Mechanized Agriculture in the production of quality seeds of the most preferred drought and submergence-tolerant rice varieties. The varieties selected by stakeholders were Sutura rice variety (heat tolerant), KAFACI 1 (drought and flooding tolerant rice variety), and ARICA 3 (pest and disease tolerant rice variety).

2.3 Parboiling kit

The demand for good quality parboiled rice is high in Mali. But the traditional parboiling process is laborious, time-consuming, and unsafe, producing rice with impurities, broken and burnt grains, and an undesirable smell, making local rice not competitive with imported rice. The local parboiling process also requires lots of firewood and water and generates low income for women, the major players in the rice parboiling process. AfricaRice and its partners have developed an improved rice parboiling technology called GEM – short for 'Grain quality enhancer, Energy-efficient, and durable Material,' – which produces rice of high physical and eating quality compared with the traditional technology. Additionally, the GEM parboiling technique makes use of rice husk and reduces the emission of black carbon and methane compared to the traditional system.

2.3 Solar-powered irrigation systems for supplemental irrigation

Effective irrigation helps farmers avoid climate and weather-related shocks by supplementing rainfall during long dry spells to maintain food production. But the high cost of diesel and electricity combined with often intermittent and unreliable energy services make traditional pumps an unsustainable option for farmers in Mali.

2.4 System of rice intensification

Water scarcity and low soil fertility are major constraints for crop production in Mali. AICCRA-Mali established a partnership with and strengthened the capacity of the Niger Office in the use of the system of rice intensification. Niger Office is a semi-governmental institution that administers the largest irrigation scheme (100,000 ha) in Mali. The system of rice intensification is a water-saving with soil fertility improvement technology that consists of the use of 15 days old seedlings, transplanting at a wider space (30 cm), applying organic fertilizer, and using an alternate wetting and drying irrigation technology.

2.5 Direct seeder

Labour scarcity as a result of climate change and conflict-induced outmigration is a major issue for agricultural development in Mali. AICCRA-Mali trained the Center for Mechanized Agriculture in the use of direct seeders for reducing the labour requirement for direct seeding and providing services to farmers.

2.6 Saving for Change financing mechanism

Limited access to finance is widely acknowledged as a major limitation to the adoption of CSA and CIS interventions. Traditional financing systems by micro-finance institutions and banks exist in Mali, but do not benefit the poorest of the poor because of the guaranty funds required on one hand, and the prohibitive interest rate on the other. To provide the first indispensable pull to the poorest of the poor, and particularly women, AICCRA-Mali established a partnership with the ANACIM NGO to promote the “Saving for Change” financing mechanism. The “Saving for Change” helps women’s farmers organize and manage groups that collect savings from the members and lend the money to themselves at interest. ANACIM NGO supported women’s farmers’ organizations in the establishment of the Saving for Change financing mechanisms and the use of the loans for making the initial investment required to adopt CSA and CIS interventions in the project sites.

2.7 Weather forecasts

Dissemination of weather and climate information services that are demand-driven, cost-effective, timely, and easy to access and implement is critical to increasing the adoption of CSA and CIS interventions. AICCRA-Mali established partnerships with Mali-Meteo to enhance the delivery of weather forecasts to smallholder farmers of the project sites using the Local Group for Meteorological Assistance approach.

2.8 Climate Data Tool (CDT)

The use of climate data in Mali for research and applications has been limited due to several factors including poor availability of and access to quality climate time series and national data policies. Combining quality-controlled data from national observation networks with satellite estimates for rainfall and climate model reanalysis products for temperature can help address this issue. AICCRA-Mali established a partnership with the International Research Institute for Climate and Society (IRI) at Columbia University to strengthen the capacity of Mali-Meteo in the use of CDT for data organization, quality control, combining

station data with satellite and reanalysis data, evaluating merged and inputs datasets, performing an array of analyses, and visualization.

3. Mechanisms used in the dissemination of CSA and CIS interventions

Various mechanisms were used by AICCRA-Mali in the dissemination of CSA and CIS interventions. Partnerships were established with the Syngenta Foundation for Sustainable Agriculture to disseminate RiceAdvice, and drought and early maturing rice varieties using the Center for Mechanized Agriculture (CEMA) business model. The Center for Mechanized Agriculture is a private organization that provides mechanized services at all levels of agricultural operations: from production to marketing and processing. They promote youth employment and boost monetary income. They also provide advice on good agricultural practices to their producer clients to increase their yield, and income. AICCRA-Mali used seven CEMA (Sigita Yiriwaton, Yiriwasso, SOCOUMA, Sene ka Sabati, Gneleni, CRPID, Kumase) as entry points to scaling RiceAdvice, and drought tolerant and early maturing rice varieties. Syngenta Foundation supported the CEMAs in accessing loans from the local banks by providing 50% of the guaranty funds, while the 50% remaining of the guaranty funds required to access the loans is paid by the CEMAs themselves. Using the loans received from the banks, the CEMAs acquire power tillers for land preparation, fertilizers, and quality seeds of early maturing and drought tolerant varieties, recruit young service providers who support farmers in the generation of RiceAdvice recommendations, and their application, and provided mechanization services for land preparation. This enables farmers to prepare their land in time, and to benefit from recommendations about the suitable period for sowing to avoid climatic stresses, the suitable varieties, and the appropriate fertilizer management (type, amount, and period of application) based on the characteristics of their fields, and their target yield. The farmers of the CEMA are able to apply the recommendations given the fact they have their fields prepared in time for sowing and that the CEMA bought quality seeds of drought tolerant and early maturing varieties, and fertilizer in sufficient quantity for all their members with a portion of the loan obtained from the bank. The CEMA business model then enables farmers to adopt early maturing rice varieties and apply the RiceAdvice recommendations, while creating jobs for the young service providers. The role of AICCRA-Mali has been to support farmers in accessing loans and training the young service providers in the cultivation of rice, and the use of RiceAdvice digital application. This is a sustainable model, as the young service providers are paid by the CEMA themselves, and not by AICCRA-Mali.

AICCRA-Mali established partnerships with Mali-Meteo to disseminate information about daily, weekly, and seasonal weather forecasts, onset, duration and drought spells within the rainy season, and information about the occurrence of heavy rains to farmers using the local group for meteorological assistance approach. The local group for meteorological assistance is designed to provide weather information and technical assistance to farmers and pastoralists to improve agricultural and livestock productivity at the local (village) level. In each of the 13 project sites, Mali-Meteo established and strengthened a local group for meteorological assistance composed of 30 farmers with which CIS information is shared every day. Each farmer member of the local group for meteorological assistance shared the CIS information with other 30 farmers, making 900 farmers reach each site, and 11,700 farmers reached for the 13 sites. However, the real number of farmers was lower than expected and was 10,608 farmers because some of the farmers members of the local group for meteorological assistance were not able to reach the targeted 30 farmers.

Partnerships were established with ANACIC to enhance women farmers' access to finance using the "Saving for Change" financing mechanism. The "Saving for Change" is a community savings group program that builds upon traditional rotating savings and credit associations (ROSCAs), but introduces the concept of loan repayment with interest, orienting the groups toward income generation and growth. The model requires no financial infrastructure beyond initial trainings to familiarize women with the program, and functions

independently from outside support once established. In this way, participating women effectively manage their own micro-institutions, with group members determining the rules of participation and systems of transparency, so that the program can be continuously modified to respond to their priorities and needs. An offshoot of the basic savings group methodology, "Saving for Change" allows for credit, but is primarily focused on savings, which are generated entirely by the members themselves without matching or external loans. Because of the program's flexibility and independence from formal structure, "Saving for Change" has been very much preferred by women in the AICCRA project sites. The members of the group get together once a week to discuss savings activities. In turn, everyone pays their agreed-upon contribution (the amount of savings varies from one group to another according to their capacities). However, it is not inconceivable for a member to choose two or more parts (arms), i.e. two or three savings payments at once. Members can apply for a loan after saving for two months. This is in accordance with the group's established rules. Each loan is subject to an evaluation in order to encourage the person to invest in an income-generating activity. After 12 months of credit and IGA savings activity, the group can decide whether to distribute its funds to all members or to carry out a joint activity in accordance with the group's established principles. After 12 months, a new cycle begins. AMACIC also uses the periodic grouping of women to provide them with agricultural technology training as needed.

In collaboration with ECOTECH, AICCRA-Mali used the "Pay-As-You-Go" business model to facilitate farmers access to solar-powered irrigation systems. The Pay-As-You-Go model has evolved beyond a financing solution to become a complete business innovation that allows for flexible online re-payments via modern information technology and improved mobile connectivity, making the system more affordable. The ability to remotely disable solar-powered irrigation systems in the event of non-payment reduces payment collection transaction costs and investment risk. As a result, the cost of solar-powered irrigation systems provided through Pay-As-You-Go has fallen below the cost of using traditional sources, providing farmers with a cleaner alternative. Pay-As-You-Go is a promising model for serving farmers with unpredictable incomes due to the cost-effective flexibility of making small re-payments. Furthermore, the online payments feature enables Pay-As-You-Go enterprises to develop business intelligence based on payment histories, allowing them to generate farmers' credit ratings, which are used to advance services beyond lighting and phone charging for their customers. The Pay-As-You-Go model has also enabled microfinance institutions and banks to serve a larger farmer base that was previously excluded due to the perceived high risks associated with farming activities, particularly in the context of climate change.

4. Number of farmers reached with CSA and CIS interventions

In total, 111064 farmers including 49% women were reached in CSA and CIS interventions in 2022 in Mali. Overall, 48% of the total number of farmers benefited from RiceAdvice recommendations; 14% of the beneficiaries had access to the "Save for Change" financing mechanism. 12% of the farmers benefited from land preparation mechanization services. 11% of the farmers had access to drought-tolerant and early maturing rice varieties. 10% of the farmers received information about daily, weekly, and seasonal weather forecasts, onset, duration, and drought spells within the rainy season, and information about the occurrence of heavy rains. 6% of the farmers had access to solar-powered irrigation using the Pay-As-You-Go business model, and about 1% of farmers had access to GEM parboiling, direct seeding machine, and multi-stakeholders platforms (Fig. 1).

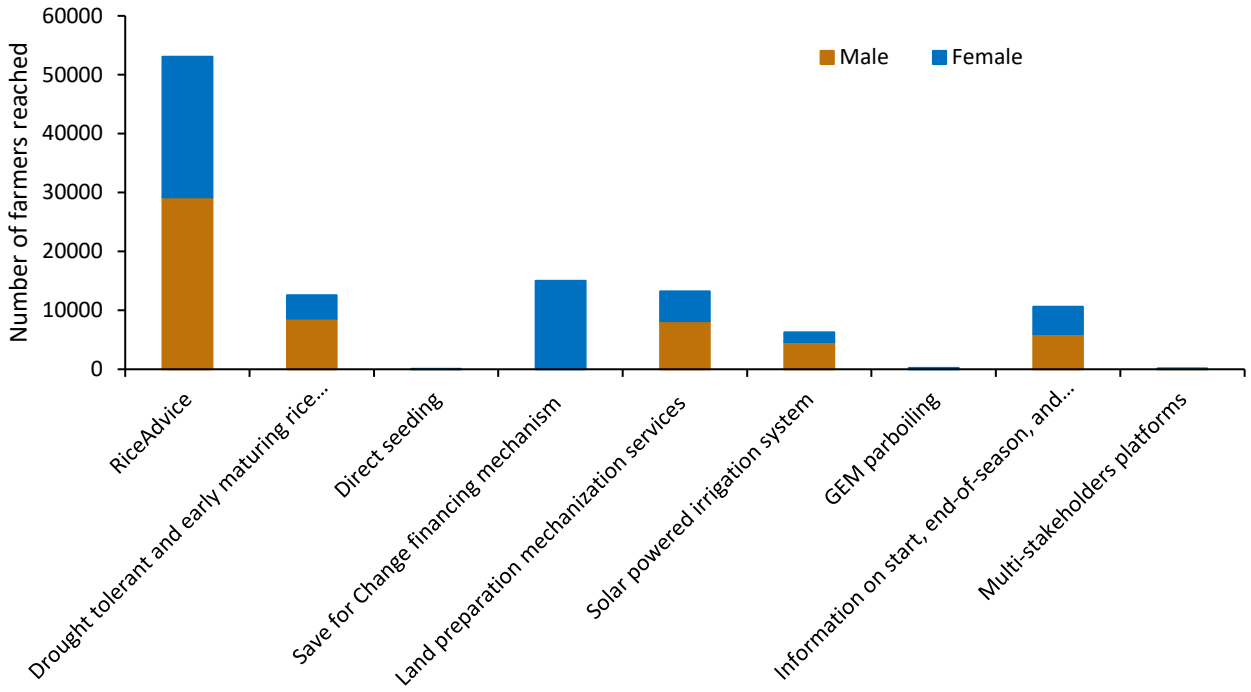

Fig. 1. Number of farmers reached with CSA and CIS interventions disaggregated by gender in Mali

5. Effects of access to CSA and CIS on farmers yield and income

Focus group discussions complemented by household surveys were used to assess the effects of access to RiceAdvice and solar-powered irrigation systems on farmers' yield, income, and food consumption scores. Focus group discussions enabled data collection on the total number of circles, the number of villages per circle, the biophysical and socio-economic characteristics of a selected site, whether a given village can be considered a control or treatment village, and the list of rice farmers of the village, while the household surveys enabled data collection on household characteristics, access to, and use of RiceAdvice recommendations and solar-powered irrigation systems and their effects on farmers' yield, income, and food consumption score.

Twenty treated villages and 18 control villages were selected for assessing the effects of RiceAdvice, while 18 treated villages and 16 control villages were selected for assessing the effects of solar-powered irrigation systems. The multi-level sampling strategy approach consisting of four steps was employed. First, we selected the districts where rice production is an important activity. Second, within the selected district, we listed all the circles, and all villages per circle, and identified the rice-producing villages. Third, we applied a sampling percentage of 10% to identify the number of rice-growing villages in which the survey will be implemented in a given circle, and we randomly selected the villages among the list of all villages of a given circle.

Forth, we categorized the village as either control (no access to RiceAdvice or no access to solar-powered irrigation systems), or as treatment (a village in which farmers have access to and use RiceAdvice recommendations or solar-powered irrigation systems). In each village, we obtained the list of all rice farming households from the village chief, and we randomly selected 30 households in each village ensuring at least 30% of the selected households are female-headed households to which a pre-validated and translated into Kobo Collect digital application questionnaire is administered. To ensure women farmers participated in the data collection, 40% of the investigators are women and collected data specifically from women farmers. Besides, the date and time of the interviews and surveys were decided by the women farmers themselves to avoid time conflicts with their households and farming activities.

Rice yield data were collected at harvest from one square meter plot installed in the center of the farmer's field. The quantity of fertilizer input was measured on a scale. Rice income was calculated by multiplying household yield (in tons per hectare) by the average unit price of paddy rice (in US$ per ton) in the market located near the selected village. Rice profit was calculated as the difference between rice income and the sum of all rice production costs, including the depreciation cost of equipment, particularly solar-powered irrigation systems. It was hypothesized that a solar-powered irrigation system has an average life span of 7 years, and consequently a tenth of the cost of acquisition of solar-powered irrigation was included in the production cost as an annual depreciation cost.

Typical socio-economic data including the age of rice farmer, household size, education level, main and secondary activities, crops produced and area, access to credit, information, market, extension services, as well as data on farming management practices including varieties, land preparation method, weed management, the quantity of fertilizer application, frequency and quantity of irrigation were collected. Food consumption score was evaluated by collecting data on the frequency of consumption of different food groups consumed by a household during the 7 days before the survey.

The implementation of RiceAdvice recommendations increased rice yield by 1.0 t/ha in women's fields, and by 0.8 t/ha in men's fields (Table 1). Across gender, the yield increase due to RiceAdvice was 0.9 t/ha. Application of RiceAdvice recommendations increased women farmers' income by 348 USD/ha, and men farmers' income by 317 USD/ha. On average, the implementation of RiceAdvice recommendations increased farmers' income by 320 USD/ha (Table 1). Higher increases in yield and farmers' income in women's as compared to men's fields were explained by the fact that women in Mali had access to fields with lower soil fertility than men's fields, and consequently, the responses of women's fields soils to site-specific fertilizer application were better than men's fields soils.

Table 1. Rice yield and income in fields in which RiceAdvice recommendations were applied as compared to fields in which farmers applied their practices of fertilizer management (control) disaggregated by gender in AICCRA-Mali project sites

	Rice yield (t/ha)		Income (USD/ha)	
Gender	Farmers' practices	RiceAdvice	FP	RiceAdvice
Female	3.5±0.3 a	+4.5±0.4 a	634±62 a	+1014±74 a
Male	4.2±0.1 b	+5.0±0.1 a	753±19 b	+1113±32 a

Three major types of irrigation systems were used by farmers in the project sites: manual irrigation in which farmers do not use any extra energy except human energy for accessing and irrigating their plots; fuel-based irrigation in which farmers used diesel as energy source, and solar-powered irrigation in which farmers used solar panel as energy source. Compared to manual irrigation, solar-powered irrigation increased the production cost by 209 USD/ha, and increased the gross revenue by 4249 USD/ha, resulting in an increase in farmers' income by 4041 USD/ha. When compared to farmers who do not produce during the dry season due to water scarcity, solar-powered irrigation systems generated a net income of 5262 USD/ha for farmers. Compared to manual irrigation and the farmers who do not produce during the dry season, the use of solar-powered irrigation increased the food consumption score by 3.1 (Table 2).

Table 2. Production cost, gross revenue, income, and food consumption scores of farmers who used manual irrigation, fuel-based irrigation, and solar-powered irrigation in AICCRA-Mali project sites

	Production cost (USD/ha)	Gross revenue (USD/ha)	Income (USD/ha)	Food consumption score
Manual irrigation	888±45 b	2109±195 a	1221±178 a	20.0±0.5 a
Fuel-based irrigation	904±79 ab	1882±368 a	979±346 a	22.0±0.6 b
Solar powered irrigation	1097±96 a	6359±423 b	5262±367 b	23.1±0.4 c
No off-season crop	-	-	-	20.0±0.02 a

6. Conclusion

This report presents the CSA and CIS interventions disseminated by AICCRA-Mali in 2022, the dissemination mechanisms, the number of farmers reached and the effects of two selected interventions for which the effects on farmers yield, income, and food consumption scores were evaluated. In 2022, 111,064 farmers including 49% women were supported in the use of CSA and CIS interventions by AfricaRice and the national partners (Syngenta Foundation, Niger office, Mali-Meteo and IER). The focused CSA and CIS interventions were RiceAdvice, drought-tolerant rice varieties, alternate wetting and drying, mechanization services, solar-powered irrigation, GEM parboiling, direct seeding, and information about weather forecasts. The mechanisms used included service provision business models, technologies demonstration followed by farmers' exchange days, save-for-change financing mechanism, Pay-As-You-Go business model, multi-stakeholders' platforms, and Local Groups for Meteorological Assistance. Application of RiceAdvice recommendations improved rice yield by 0.9 t/ha and farmers' income by 320 USD/ha. The yield increase was higher in women's fields (+1.0 t/ha) compared to men's fields (+0.8 t/ha), which was attributed to the fact that women have culturally access to soils with lower fertility than men's in Mali, and consequently, the soil responses to applied fertilizers were better in women's than in men's fields. When the benefits of the use of RiceAdvice were aggregated over the total area cultivated by the 53,045 farmers, the rice production increase was estimated to be 42966 tones and the farmers' income increase was estimated to be 15.3 million USD. Farmers who used the solar-powered irrigation pumps increased their income by USD 5,262 per hectare, and improved their food consumption score by 3.1. The food consumption score is the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. The use of solar-powered irrigation technologies enabled farmers to produce cash crops such as onion, tomato, cabbage, and potato during the dry season when fields had previously been abandoned due to water scarcity. Thanks to these additional crops, the increase in their incomes mean they are investing more in quality seeds, and fertilizers.

About AICCRA

Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) is a project that helps deliver a climate-smart African future driven by science and innovation in agriculture.

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Discover more at aiccra.cgiar.org