2021 Pilot of Crop Watch and Weather Analytics for smallholder farmers in Kebbi & Jigawa Nigeria

1. Background

A key driver for improving farming practises is access to information and knowledge. The limited numbers of public extension workers in Sub-Saharan Africa mean that farmers often have only poor access to extension services or none. The ratio of 5,000:1 between farmers and extension workers does not allow intensive and individual assistance (NAERL, 2018; Agricultural Performance Report 2018 by NAERLS, 2020). Beside the inadequate number of Extension Agents (EAs), face-to-face extension service delivery is expensive and time consuming. Thus, many of the EAs are not informed about most recent advances in the agricultural discipline, especially Precision Agriculture, Climate-Smart Agriculture (CSA) and other recent ag-technologies which can be helpful in improving farmer productivity and crop yield.

In partnership with the Green Innovation Centre for Agriculture and Food Sector, the CARI aims to address the above through a combination of remote sensing and other digital technologies provided to deliver personalised agronomic advice to farmers via in-person (using voice call, text messages or mobile app (self-service). Rural Farmers Hub develops and distributes digital technologies that address the aforementioned which is being studied in this pilot program. The technologies under review are:

1.1. Crop Watch and Analytics

- Crop production planning: Extension Agents (EAs) will be trained on how to use ICT tools to evaluate the viability of a farm and generate reports for mitigating risks for each farmer.
- Crop health monitoring: EAs will be trained on how to use a remote sensing tool called Capture in monitoring crop health from germination to harvest with near-real-time alerts and recommendations on what to do.
- EAs will conduct remote soil nutrient evaluation and geo-spatial visualisation with precise yield-based fertilisation tips.
- EAs (and farmers) will learn how to monitor for and receive alerts on water stress.

1.2. Weather Analytics

- EAs will use the weather modules in the Capture app which combines accumulated temperature and P/PET (Precipitation versus Potential Evapotranspiration) to estimate the growth and development of crops and insects during the growing season.
- Weekly forecast (5-10 days) and seasonal forecast based on P/PET.
- Optimal planting date prediction, yield prediction/date.
- Pest and disease monitoring, detection and control.

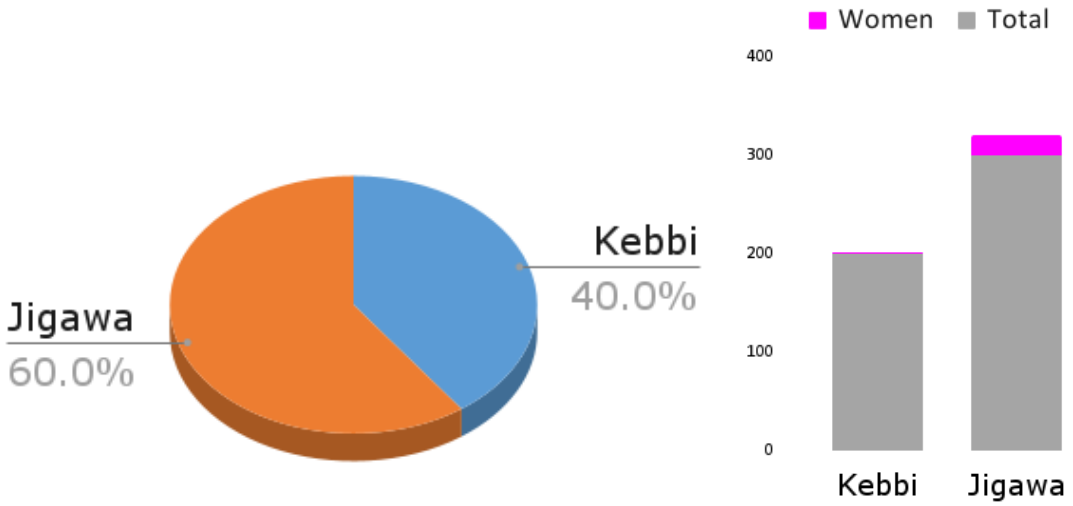
2. Objective of the assignment/pilot

The assignment is piloting two digital solutions, crop watch & analytics and weather analytics to provide personalised agronomic advice to farmers via in-person. On the premise that new digital agriculture technology can increase smallholders' productivity in sustainable ways. Hence the objectives below:

- To measure the cost benefit and scale of e-extension digital tools, i.e , crop watch & analytics and weather analytics in providing extension services compared to cost benefits of face extension service for smallholder farmers
- Yield increase and profitability off their farming enterprise in the rice value chain
- To examine if digital tools can help mitigate the risk associated with weather.
- To find out if access to climate smart technology can help build farmers' resilience against climate change.
- To measure the sustainability and scalability of business models; see "***Scalability Analysis template (CWTool30)***".

3. Task/Activities

The consultancy/solution provider is required to geo-reference 500 smallholder farmers that CARI works with in Kebbi (200 farmers) and Jigawa (300 farmers) states, particularly the farmers that have been trained on Good Agricultural Practises (GAP)/Sustainable Rice Production (SRP) conducted by CARI. Only 367 farm records were geo-referenced where 23 (or about 6%) of them are women, 21 of the 23 women are from Jigawa state. Effort to get the EAs concerned to complete the task was futile.



3.1 Deliverables

- Evidence of baseline study conducted
- Signed letter of intent with CARI MF partners Aggregators/Off takers
- Activity implementation report, including lessons learned during pilot, ICT scalability assessment, monitoring and evaluation reports and critical reflection on farmers feedback
- Evidence that 500 smallholder farmers were geo-referenced on capture
- Further evidence must be provided that these farmers are in a contracting arrangement with the aggregators/off takers CARI works with
- Further evidence must be provided that these farmers were previously trained in GAP/FBS

3.2 Estimated Timeline

The contract ran from February 15, 2021 to November 10, 2021

3.3 Tasks

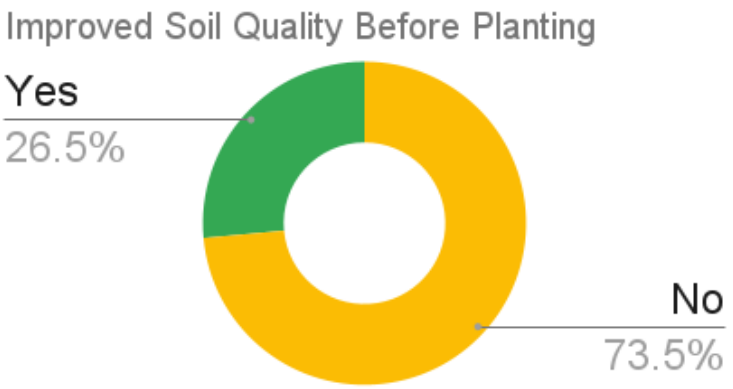
To achieve the objectives, the consultant is expected to fulfil the following task:

#	Activity	Period	Status	Update on Activities (Narrative)
1	Community sensitization	Jan 21 to Jan 26	Done	We held stakeholder engagement meetings with farmers, extension agents and staff members of CARI in Jigawa and Kebbi states on the 27th, 28th, and 30th January 2021. ● Argungu event - 21st & 22nd Jan, 2021 ● Gumel event - 25th Jan, 2021 ● Hadejia event - 26th Jan, 2021 The project kicked off with a stakeholder meeting of farmers, extension agents and a representative from Kebbi Agricultural & Rural Development Authority (KARDA) at the ADP office in Argungu, Kebbi state on January 21; about 20 persons were in attendance. The day after, we held a specialised training session with the extension agents on mapping and georeferencing of farms. The sensitization train then moved to Jigawa state where a similar event was at Green Sahel's office in Gumel on January 25th and at Gawuna Primary School Hadejia (% Atafi Agro). About thirty (30) farmers from Green Sahel and seventy five (75) from Atafi Agro were in attendance for Jigawa state, bringing the total across both states to over 120 farmers in attendance for the sensitization event. The meeting began with opening prayers that was followed by a round of introductions by all attendees. Gabriel Eze of Rural Farmers Hub kick-off with a presentation on precision farming and other technologies for farming. He highlighted the declining crop productivity among most smallholders over the past 30 years. Among other reasons, but the primary cause is a widespread use of legacy farming practice that is not backed by data. This is further compounded by farmer's lack of resilience

				to climate change. After the presentation and a round of Q&A, we reached consensus with the farmers to go ahead with the pilot. Food and/or snacks was shared with attendees, followed by a group photograph before the meeting came to an end.
2	Recruitment and registration of EAs	n/a	Done	The assessment, selection, and recruitment of eight (8) extension agents was supervised by the GIZ CARI team and her other partner(s). This activity was completed.
3	Training for EAs on Mapping and networking of farmland and related assets (Geo-referencing)	Jan 21 to Jan 26	Done	After the community sensitisation meeting in the last week of January 2021, the farmers were released to return home while the EAs stayed back for their onboarding and first training. During this time, they received a deep-dive into precision farming methods using satellite remote sensing, followed by a walkthrough of Capture (an e-Extension tool that leverage satellite and other big data for generating crop insights and soil quality assessment), then a drill on their workstream during this pilot, and finally an on-field demonstration of how to map farms and upload to the Capture platform. The Q&A session was underway before it came to a close. This training took place at the KARDA office in Argungu (for Kebbi) and, for Jigawa, at the offices of GSARDI and ATAFI respectively. After the training, the extension agents received hardcopy of the “Remote Extension Delivery” manual with live simulation of the workstream from interpretation of weather data (wind and rainfall for optimal decision making) to calculating nutrient requirement and application timing using RFH’s fertilisation program.
4	Training for EAs on Remote Extension Delivery (RED) with Simulated field experience on a demo plot	Apr to May	Done	This training (2 of 3) took place at Birnin Kebbi for Kebbi state as well as at Green Sahel and Atafi Agro offices in Jigawa state on April 28 and May 4-5th respectively. During the training, the extension agents received hardcopy of the “Remote Extension Delivery” manual with live simulation of the workstream from interpretation of weather data (wind and rainfall for optimal decision making) to computing nutrient requirement and application timing using RFH’s novel fertilisation program. Sequel to training 1 of 3, we had planned a continuous modular training of extension agents to consolidate the precision farming concepts taught through a virtual platform - WhatsApp. This was not effective at first because the initial training in January was inadequate as all EAs struggled to follow through the defined workstream except for Ahmad Ya’u Ahmad (Atafi Agro, Hadejia, Jigawa state). For commendation sake, Alhassan Sani and Hassan Tata excelled from that first training both of KARDA in Kebbi state. Looking back, we should’ve attempted to promote Ahmad Ya’u Ahmad and Sani Alhassan as lead EA to help with continuous retraining of the rest.

5	Selection and interview of 500 farmers	Feb	Done	After training 1 of 3, extension agents embarked on the selection process of farmers who participated in the pilot; the baseline criteria is they must be smallholder farmers and there must be gender balance. This process was supervised by the CARI team and partner(s).
6	A webinar on 2021 Seasonal Climate Forecast	Apr 1	Done	The essence of conducting a seasonal forecast for agricultural activity is to help farmers, agribusiness, and stakeholders plan and mitigate natural occurring risks associated with such activity. It is **NOT** exact science. However, forecasted outlooks have a high confidence level with eventual outcomes. The forecast will help us determine optimal planting window, expected amount of rainfall, projected dry spell, major triggers for flood.
7	Baseline survey of 500 participating farmers		Done	See section 4 below for details.
8	Geo-referencing/Mapping of 500 farms	Feb 10 to May 5	Done	**367 farms** were mapped between February and May 2021. As expected, this was a very physical exercise that is begging for automation; however, while RFH has the software tool to automatically map farms, the tool itself requires a substantial amount of ground truth data from this type of exercise to achieve human-level precision making it a zero-sum case at the time.
9	Geo-referencing/Mapping of agro input dealers and other relevant stakeholders (GIZ/CARI handles the selection process)	n/a	Skipped	This sub-activity was omitted for a lack of alignment with the flow of the project. However, some agro input dealers were mapped in Kano but this market data point was not utilized throughout the project timeline so far, and Rural Farmers Hub takes responsibility for this inaction. It was proposed that existing agro dealers working within the project will be onboarded for the pilot and the stakeholders' engagement was to be included in the kick-off plan; the list of agro-dealer was not provided and Rural Farmers Hub failed to follow-up. In retrospect, this was a big missed opportunity on our side.
10	Training for selected/participating agro input dealers and other relevant stakeholders	n/a	Skipped	This sub-activity was omitted for a lack of alignment with the flow of the project. However, some agro input dealers were mapped in Kano but this market data point was not utilized throughout the project timeline so far, and Rural Farmers Hub takes responsibility for this inaction. It was proposed that existing agro dealers working within the project will be onboarded for the pilot and the stakeholders' engagement was to be included in the kick-off plan; the list of agro-dealer was not provided and Rural Farmers Hub failed to follow-up. In retrospect, this was a big missed opportunity on our side.

11	Training for the GIZ CARI team	Apr 13	Done	Prior to this activity, a copy of the training curriculum was shared with the project staff. The training was combined for both GIAE and CARI staff and lasted for 2 hours starting at 10 am WAT; members from the implementing partners (Federal Ministry of Agriculture and Rural Development, FMARD) were also in attendance too. A total of four (4) members from the GIAE team participated in the training while another three (3) came from the FMARD. The training was facilitated by Gabriel on behalf of Rural Farmers Hub. During the simulated demonstration of the digital tool in-training, we experienced some issues but it was resolved just afterwards. After the training, a copy of the presentation as well as an article on precision farming authored by Rural Farmers Hub was shared with the training attendees.
12	Processing and clean-up of geo-referenced data	May 1 to May 30	Done	Inconsistencies in farm data uploaded ranges from non entry of Partner ID, incorrect Partner ID entered, to mismatch in the village name entered. In retrospect, the Partner ID and village name should've been coded into the app and available through a dropdown menu, or auto-filled by a non-fungible valid reference data.
13	Actual field trials for/by EAs	Mar 3 to Mar 4	Done	This activity was carried out alongside training 2 of 3
14	Step-down training for farmers by EAs	Mar 3 to date	Done	Extension agents meet with farmers periodically to step-down the training received as a result of this project. Modules include; ● improving soil quality ● Variable rate application of farm inputs (seed, fertiliser, pesticides, etc) ● See rate (during planting) ● Fertilisation program This pilot introduces new methodologies that require some behavioural change by the farmers. This requires additional enlightenment of the farmers, presenting them with superior arguments in favour of why this change is necessary for further improvement of their expected farming outcome.

				 For example, we required the farmer to test for soil pH and carbon content pre-planting using Capture app; where there are deficiencies, they are recommended to apply liming material or mulch as the case may be, and on the contrary, not do any of those. Prior to the pilot, it was a common practice by some farmers to apply liming material pre-planting; this action, when not required, deteriorates the soil condition. Another case was the tweak to their fertilisation program, a change that was confusing to the farmers at first. We proposed for farmers to apply fertiliser in the following order: 1. Urea 2. NPK (first split – minimal) 3. NPK (second split – maximal) It took a testimonial from EA Alhassan Sani and a few other farmers who had experimented with this fertilisation program to gather some affirmation from farmers. With continuous weekly meetings, minds began to turn gradually. We later realised this program may not be entirely applicable as it was designed for direct-seeding (not transplanted) rice. Regardless, we proposed that step 2 and 3 be adapted. This new fertiliser program was counterintuitive to most farmers coupled with the additional labour cost it imposes on them; applying fertiliser twice is already a burden, asking them to further split and apply 1 times is a stretch (farmer alluded). Should there be an automated means of applying fertiliser that is less stressful and affordable, we might have had a better reception and adoption of the fertilisation program.
15	Go live (planting window)	Jun 07 to Jul 15	Done	EAs are required to set the planting date for each farm under their portfolio for accurate calibration and personalisation of the advisory the farmer received.
16	Monitoring & evaluation (Weekly check-in virtual call)		Done	Sequel to the baseline survey, we held weekly virtual meetings with EAs during which individual performance is assessed, complaints are heard, and additional (short) training delivered.

				But for a few times the check-in session was postponed, it was held consistently for the period under review.
17	Submission of final report (harvest data gathering precedes this activity)	Dec 2021	Done	Attached herewith

	Unplanned Activity		**Status**	**Narrative**
	Retraining exercise for extension agents in Zaria	Aug 8	Done	Following the initial training, some of the EAs still did not understand the core of the pilot program which is precision farmer. How it helps farmers manage yield expectations, optimise farm input, lower the cost of production, and general improvement at the micro level. Some of the EAs did not understand their role in bringing it to their farmers effectively minimising the impact of first training (maybe it was inadequate). The follow-up exchanges on WhatsApp were not enough to get them started. Because the technology is new, this is understandable; however, what is disappointing is that the affected EAs did not bring this to the notice of RFH in time.
	Monitoring & evaluation (Weekly check-in virtual call)	Jul 9 to End	Done	We introduced a weekly meeting with extension agents for the rest of the 2021 wet season. We were encouraged by an earlier revelation from previous training that we need something like this. The proposed format is a Google Meet call. During this time, EAs will share their experiences, difficulties, and even any good news from their respective communities. This would also be an opportunity to learn more about Capture, how it can help with everyday productivity, and what new features should be introduced.
	Weekly meeting with farmers	---	Done	Extension agents were mandated to hold weekly meetings with farmers and bring report of the outcome of such meetings to the weekly check-in session (Google Meet)

4. Survey method

In order to measure and track the effect of this assignment, we opted for a simple questionnaire survey of both farmers and extension agents. A total of 3 surveys were conducted:

- Baseline survey
- Focus Group Discussion, and
- Endline survey

Measuring key data as a baseline helps to understand the agent and farmer's situation before the intervention/assignment, so as to determine at a later time how such intervention affected their situation while helping to identify areas of the solution that can be improved upon. The survey questions was categorised according to the following themes:

4.1. User history of using digital tools for farming

- If they have used digital tools for farming in the previous season(s). If not, what are the barriers? If yes, which one(s)?
- If they know about and use soil data (e.g. pH and organic content) and its impact?
- If they make farming decisions based on weather and climate insights? What farming activities are these insights used for?
- If they use fertiliser? If not, why? Do they carry out soil tests before planting or applying fertiliser? How or where is this test carried out? How do they determine the amount of fertiliser that is required? Is fertiliser amount based on how much harvest is expected (and has this been consistent with previous results)? Fertiliser rate per hectare?
- Do they space seeds uniformly when planting? If not, why? If yes, why is it important? How many seeds do they plant per hole (and why)?
- How do they check for crop disease, others?

4.2. User cropping/farming history

- What is their reason for farming (subsistence, to sell some, to sell all)
- If they have other business enterprises apart from farming and why?
- Crop grown in the last 2 farming seasons?
- Planting and harvest dates for each crop in both season (if applicable)
- Yield for each crop in each in both seasons (if applicable)

5. Baseline Survey

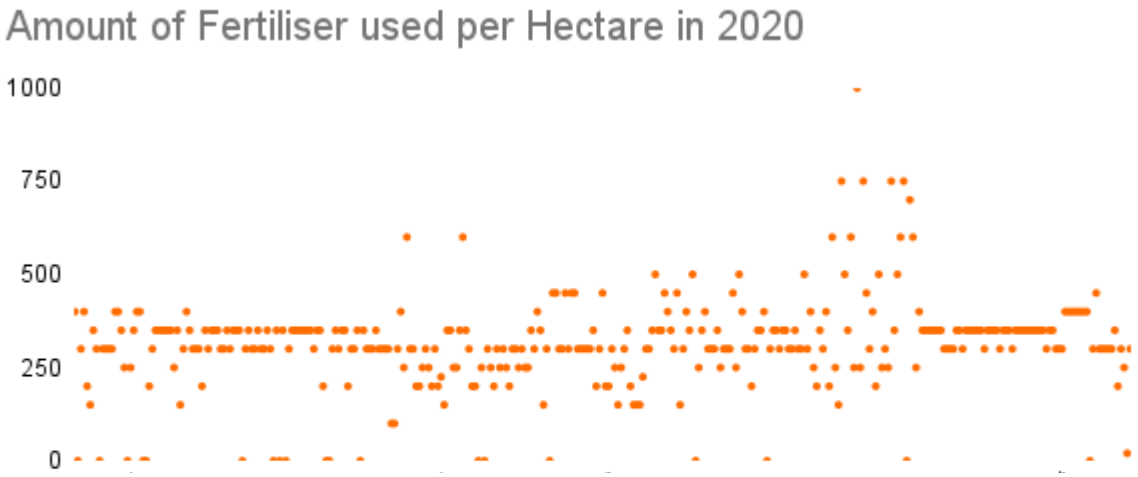
We interviewed **335 rice farmers** who participated in this pilot. Our goal is to get a sense of their situation in the previous (WS 2020) cropping calendar and use such a baseline for analysis. Here are what we found:

- Baseline survey sample size is n=335

- The farmers are split evenly (50% each) between those who have used digital tool(s) for farming in the previous farming season and those who have not.
    - For farmers who don't have a history of using digital tools, the primary reason for this is distributed between
      (a) lack of awareness—40%, (b) low ICT literacy level—19%, and (c) preference for legacy farming methods—16%.
    - For farmers who have used digital tools, they indicated Digital Advisory Services, e-Extension Services, and Digital Market Linkage solutions as examples with the weight leaning heavily to the first two—174 of 178 responses. Further inquiry revealed that the majority of the farmers were actually referring to the

Capture application under pilot, leaving us with Digital Market Linkage as their only history with digital tools for farming prior to the pilot.

- 80% of farmers do not carry out soil nutrient and other properties analysis before planting; as a result, the amount of fertiliser use was not determined by some ground-truth data. However, a majority of farmers agree that such analysis is important and does have consequences on the farm's outcome.
- 98% of farmers acknowledge that weather information is an important metric for farming decisions, particularly for such farming activities as planting and harvesting. It is interesting to note that these farmers also did not know weather information plays a critical role on the timing for fertiliser which also affects the uptake efficiency of such application.
- The average fertiliser application rate is 170 kilograms per hectare; this is less than the government's generalised recommended minimum of 250 kilograms per hectare; the single most commonly used determinant of the amount of fertiliser to use by farmers surveyed is the size of the farm.
    - 19 of 337 of the respondents used 500-1000 kilograms of fertiliser per hectare (representing ~6% of the farmers); this is indicative of over-supply of fertiliser to the soil.
    - Only 8.3% of farmers used the government's generalised recommended minimum of 250 kilograms per hectare.
    - A super majority of the farmers undersupplied fertiliser to the soil in 2020.



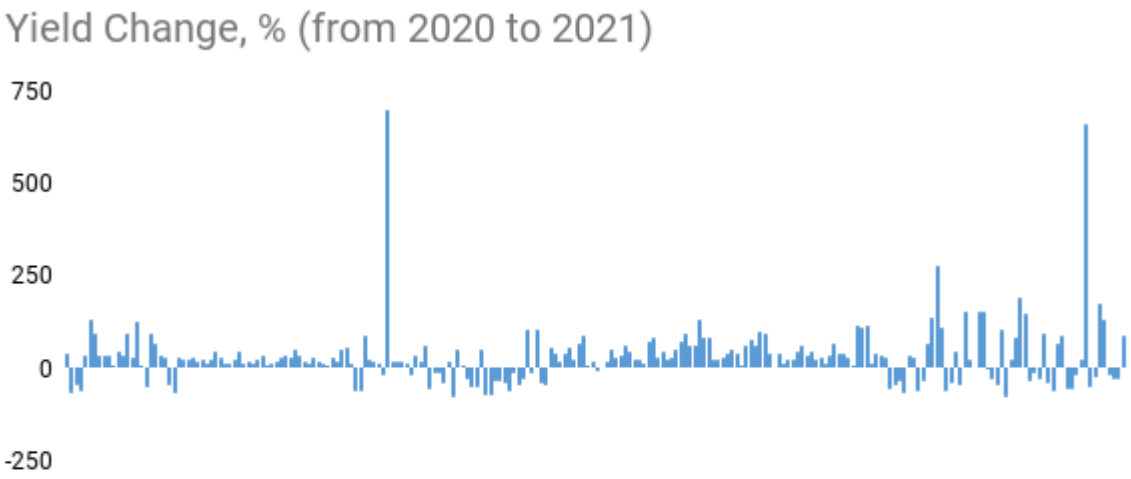
    - There's an URGENT need for improved fertiliser management by farmers in Jigawa and Kebbi states. The farmers were largely sticking to a generalised fertiliser recommendation to the crop.
- Majority of farmers still rely on physical observation of signs and symptoms on the crop to detect and diagnose crop diseases and points of failure.
- The farmers are split evenly (50% each) between their reasons for engaging farming — subsistence and commercial alike.

- The data also shows that farmers don't earn a living wage from farming alone, 76% of them say they are engaged in other activities outside farming to earn additional or supplementary income.
- The farmer's average yield for rice in the 2020 wet season is **2.42** MT**.**
- The maximum yield (2020) was 6.8 MT while the minimum yield (2020) was 0.1 MT.
- It is estimated that the cost of **visiting a farmer per day** could be as high as N2,500 because most of the farmers live and farms are far apart in remote villages which are time-consuming and expensive to visit.

6. Endline Survey Findings (Results)

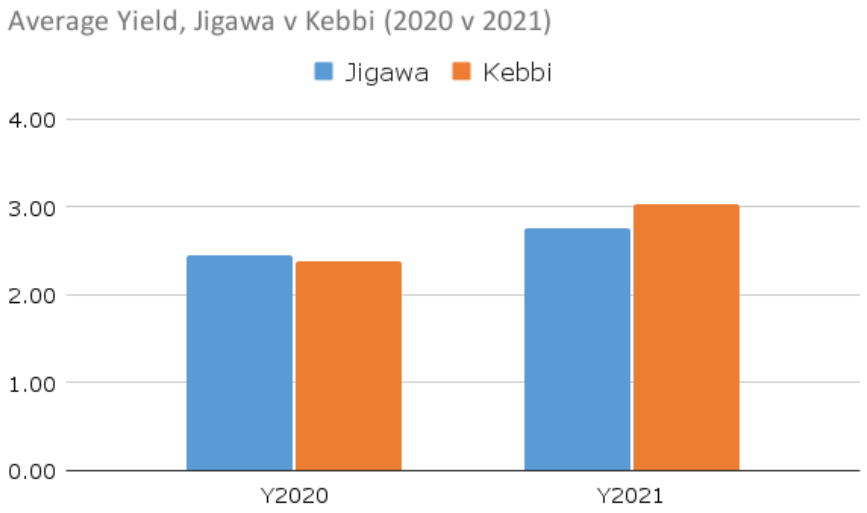
We interviewed 170 rice farmers who participated in the 2021 cropping calendar for the pilot under review. Our goal is to find out how the intervention with the aforementioned digital tools impacted the rice farmers. Here are what we found:

- Endline survey sample size is n=241 where Kebbi is 51 and Jigawa is 190
- Average farm size is 0.40 hectare. Total rice output is 496.10 MT. Total area cultivated is 70.94 hectare.
- The job of eight (8) extension agents was improved to include advisory on climate-smart farming. Two (2) of them are women and both of them were recruited from Jigawa state representing one-quarter of the distribution; it means there were no woman extension agents recruited for Kebbi state.
- For the 2021 cropping calendar under review in this pilot, the average yield recorded is **2.82** MT, an increase of **37.5**% (yield change). Please note that we did not receive any yield data from Kebbi as at the time of filing this report.
- The maximum yield (2021) was 15 MT while the minimum yield (2020) was 0.18 MT.



Although the yield change is a bit greater than the projected 30% increase set out from the onset of this project, there are some interesting positive layers of data to what we've found:

- The ratio of farmers who saw a positive yield change is 3 times greater than those that saw a negative change. The total yield gained (+11,597%) outweighs the total lost (-2,560%).
- All change indicators are positive for both states with Kebbi experiencing the bigger change of the 2 states, the average change from 2020 to 2021 is net positive (+27.19), the reason is expressed above and here reiterated: the weight of increase far outweighs the loss by 3X.



- When you zoom into the yield change data by state, you will notice that the aggregate positive surge in yield for Kebbi state (see chart above). While Jigawa's average yield for 2020 is greater than that of Kebbi, the latter made a bigger leap in 2021.
- Farmers in Kebbi also reported that they spent less money on rice production in 2021 than they did in 2020.

- Farmers are happy with the positive yield change amidst many lessons learned. EAs in Kebbi reports that some of the participating farmers are eager to repeat their success this dry season.
  - Nearly 91% of them said they are happy with the service and willing to pay for crop advisory services.
  - Presenting these data to the farmers in the coming year might lead to a better outcome in terms of reception and adoption of some of these methodologies in the upcoming season.
- Using a combination of Capture app and weekly meeting with farmers, extension agents reported that they spent an average of **N13,200** per month in order to provide personalised precision advisory and extension service. The average number of farmers

served using this approach by 1 extension agent is 58; therefore the monthly unit cost of service provision per farmer is N228 (excluding software licensing/subscription costs. Below is a breakdown of how the costs was derived;

- N3,200 per month on the average is spent on internet subscription that enables them to access the Capture app (the climate-smart tool)
- For their mobility (fueling bike), the average monthly cost is N10,000; however, this is projected to increase once the Federal government of Nigeria go ahead with the removal of fuel subsidy in the coming year
- In contrast, if the agent is to visit each individual farmer personally (an ideal situation that compares with the pilot methodology), it will cost N2,250 per farmer for at least 1 farm visit per month. At 58 farmers, that will amount to an average of N130,500 per month to serve all 58 farmers.

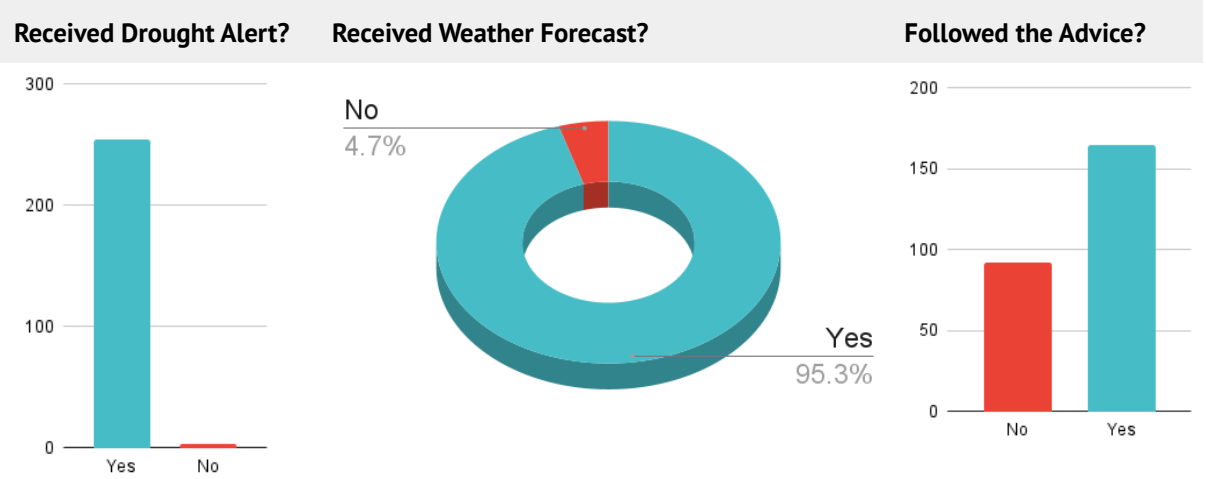
	Pilot Approach *(Weekly check-in & Capture app)*	**Legacy Approach** *(Monthly check-in on farm)*
Monthly Unit Cost (per farmer)	N228	N2,250
Annual Unit Cost (per farmer)	N2,736	N27,000
** Excluding software licensing/subscription costs*		

- It can be argued that traditional farmer group meetings are a cheaper alternative to the pilot. However, without the data-driven and personalised crop advice, the uncertainty and unpredictability of crop yield creeps in. During such traditional meetings, additional cost may be incurred if refreshment (customary), external trainers and experts are to be included.

- Sequel to the potential fuel subsidy removal in 2022, this pilot approach to extension delivery is still cheaper (see table above). At an annualised software subscription rate of N10,000 per unit/farmer, the total annual unit cost will be N12,736 which is 53% cheaper than the legacy approach.
- Using cost-benefit analysis, the findings show that additional N50,100 (average) in new income is gained by the farmer after the pilot. This means that spending N12,000 to get an extra N50,000 seems like a good business; and this is not even the optimal outcome.
- The average farm size of the farmers is 0.43 hectare, the actual service fee payable by the farmer is about N5,160 per year or N430 per month.
- During the pilot, EA in Hadejia used the digital tool to mitigate the risk associated with projected strong wind. The measures recommended did not completely prevent, but allowed for the rice to recover after the wind shock.
- Some farmers in Kebbi reported that they spent less money in their rice production.

- Digital extension service tools like Capture affords the opportunity to deliver quality and personalised advisory to multiple farmers simultaneously, digitally, and at scale. Prior to the weekly meeting, the farmer must have received SMS advisory; and during the physical group meeting, the extension agent advises the farmer on a personal basis rather than the generalised approach associated with the legacy practice.

  Analysis of the responses showed that most farmers received drought alerts or weather forecasts. About two-third of farmers who received these insights actually applied them. Farmers were already familiar, accepted, and were using weather to make farming decisions prior to the pilot; Weather Sense takes this further by introducing granularity and precision to how weather insights is better optimised.



  Following the seasonal weather forecast virtual workshop, the potential for dry spells in-season posed a threat to expected rainfall amount in the locations under review in this pilot. The awareness helped farmers prepare against them. For example, 29 of 40 farmers in Darmomuwa lost their crop in the 2020 season; this time around, they asked about preventive measures ahead of the season. Luckily, there were no flood incidents recorded. Without rushing to take credit, we will investigate further to evaluate to what extent the digital tool and/or related advisory played a part in it. One thing we know for sure is that the same was used in both seasons, ruling out any suggestions that they might have changed farmland.

  Another common resilience mechanism used by farmers prior to the pilot was to partially irrigate any affected rice farms during the dry spell; the only constraint to this resilience will be the absence of irrigation channels or boreholes.

- Coming into this pilot, about 50% of the farmers said they did not have prior experience using digital tools for rice production. However, 305 of 335 respondents (91%) said they are willing to pay for digital advisory services, especially one tailored to their needs and includes input financing and access to market.

- To measure the sustainability and scalability of business models; see "***Scalability Analysis template (CWTool30)***".

Focus Group Discussion (with EAs)

- 100% of the participating extension agents own a smartphone, and are able to carry out basic actions with it without any supervision. However, there are areas that still require capacity building (e.g. video conferencing, virtual interactive such as screen share, etc). All of them also had received agricultural information on smartphones before Capture.
- Sources of this information include: Farm organisation (e.g. Green Sahel), Service Experience Schools, GIZ CARI, Radio, Mobile app, Training, WhatsApp, Phone, Email, SMS, and Input Suppliers.
- 5 of 8 EAs said they have used one mobile app or the other to support farmers in extension delivery and advisory prior to Capture app; such apps are Rice Advice and Weed Manager. 1 EA suggested that the survey app be included, but the consensus voice did not agree that it should be included as it is not an "agric extension activity".
- 3 of 8 EAs said they don't use their smartphone often, indicating that they acquired and use it for work only (ag extension delivery). Another 3 of 8 said they use their smartphone quite often but not at the extreme as the remaining 2 of 8; common use cases include WhatsApp chats, following news updates, and watching YouTube videos.
- 3 of 8 EAs spent less than 1 hour on their smartphone per day, the remaining spends 5 to 10+ hours per day; however, the distribution leans more towards 5 hour/day.
- On how trust can be nurtured between farmers and mobile advisory services providers, it would seem as if farmers have been burned from previous experiences with various providers over the recent years. The message is that service providers fulfil their promises (in proposed offering or benefits) to farmers. EAs also subscribed to the notion that a good result/achievement speaks for itself; when farmers are impacted positively, trust is either built up or consolidated. Also, supervision is important; periodic and follow-up visit of the farm/farmers is key to building relationships with the farmer.
- Network reach (especially internet penetration) at the farm area is very limited; the EAs advocates for aid in improving the network quality.
- 5 of 8 EAs do not currently pay to use mobile advisory services. The common reason is that there are different other needs the one app may have and the other may not have. However, when there is such an app that can provide **All-in-One** services (e.g., GAP advice and mechanization service, access to finance, etc), the EAs say they will be willing to pay the mobile service provider to use the app.
- The following are the barriers that could stop farmers from adapting information from mobile apps:
    - If the result of the information was negative (poor result),
    - If the information is above their literacy level (or if there are not medium for stepping such information down to them always),
    - If the information is in a language they do not understand,

    - If they don't have access to or own smartphone,
    - If they cannot afford to pay for the information service as a result of poverty

- According to the EAs, they deliver agricultural extension service to the farmers through one or more of the following channels:

    - Training (2 responses)
    - Demonstrations (1)
    - Film/video shows / multimedia (2)
    - Mobile app (1)
    - Group meetings (1)
    - Face-to-face / farm or home visit (4)
    - Phone calls (3)
    - Text messaging (1)

- It is important to note that during this pilot, apps (particularly Capture) is at the centre of some of the above indicated face-to-face meetings, whether individual or group.

- Generally, there's a high level of understanding and use of mobile apps for receiving agricultural information among the EAs. This understanding is at the beginner's level with needs for continuous development. EAs also strongly prefer the use of mobile apps for receiving agricultural information in rural areas

Deliverables

#		Means of Verification
1	Evidence of baseline study conducted	link
2	Signed Letter of Intent with CARI MF Partners and GIAE Agro Input Dealers	**n/a**
3	Activity implementation report, including lessons learnt during pilot, monitoring and evaluation reports and critical reflection on farmers' feedback	link
4	Conducted a "crop cut" to measure the percentage change in yield of participating farmers **PS: We used an endline survey as we are not familiar with crop cut methodology prior to writing this report.**	link
5	Evidence that 500 smallholder farmers were geo referenced on Capture	link
6	Further evidence must be provided that these farmers are in a contracting arrangement with the agro input provider that CARI/GIAE works with	**n/a**

7	Further evidence must be provided that these farmers were previously trained in GAP/FBS	**n/a**

7. Challenges

- **Varying ICT literacy levels**: Some of the climate-smart methods introduced to the EAs were too advanced for their current stage of learning; particularly, Growing Degree Days (GDD), a weather-based performance metric for monitoring crop development. It is a measure of heat accumulation used to predict plant and pest development rates until it reaches maturity.

- **Mobile compatibility**: Perhaps surprising, we learned that the cheaper (lowest end) android devices were not suitable for mapping farmlands. Mapping a farm together with other references is prerequisite to receiving climate-smart advisory. We noticed that in order to accurately map a farm, the android device containing the Capture app must possess certain minimum location communication options for its Assisted-GPS chip. The cheaper (lowest-end) android devices tend to have just the baseline A-GPS option; and accuracy of the georeference increases with more options like GLONASS, Galileo and BDS on top of A-GPS (the more, the merrier).

- **Behavioural pattern of the tool adoption:** While farmers received essential advisory via text message, it is undeniable that internet access for the EAs allows for richer and more granular insights that ultimately benefits the farmers through face-to-face interaction. Not surprising, farmers preferred the human interaction layer by extension agents on top of the digital experience, who they believe will step down/explain the advisory better to them and also answer their questions. Farmers also showed a bigger than expected appetite for face-to-face interaction, as the information will come to them in more language options than oral; they said they are willing to pay for it as well at the correct pricing tier.

- **Text messages alone are not enough:** Some farmers had to physically meet with the responsible EAs to know what area of their farmland needs attention. There's a need for a Capture app but for farmers; with this, farmers will be able to fully visualise the advisory from Capture and consult EA for additional specialised input.

8. Opportunities/Recommendation

- Sequel to the above challenge, there's a case to be made for additional training reinforcement for extension agents on the recent advances in the agricultural discipline, especially precision agriculture, climate-smart agriculture (CSA) and ag-related weather concepts which can be helpful in improving farmer productivity and crop yield. The

agents will be able to train the farmers under their portfolio to be self-dependent in receiving and carrying out advice provided;

- There is a huge opportunity to increase the number and quality of extension agents by tapping into a young population that is tech savvy. This can be done sustainably through a market-let approach. Prospective young EAs will be trained in precision farming (as advisor) and trading (commodities and input resale), then given a line of credit as startup capital.

- There's an urgent need to expand the spectrum for recruiting extension agents into the ecosystem. While the capacity of government extension agents will continue to be improved, more independent candidates like tech-savvy young men and women across different educational levels can quickly be trained into CSA advisors in a private sector led model. Theses candidates can then be embedded into the ADP in secondment where they function as "***Extension Agent in Residence***" (EAiR or EAR);

- As long as the internet penetration, smartphone penetration, and literacy rate among farmers remains high, mobile apps will not replace human extension agents per advisory services; rather they will complement and supercharge them. Human interaction is key in boosting the adoption of technology by farmers, but the recruitment process must be objective and conducted in a professional manner.

- Sequel to the above, Rural Farmers Hub is currently piloting a model physical hub at the village level using a franchise model. This franchise gives the community and local government some ownership of the business hub where it employs and trains extension agents (particularly young graduates) from the host community on climate-smart agriculture, agric business administration, financial literacy, marketing and sales. Farmers are registered to this hub (paid membership) after which a timetable is drawn for groups of members to check-in to the hub for a weekly meeting with the extension, during which training, capacity building, consultation, and even introductions or negotiation with market actors can be conducted. Within the hub is a 1 acre demo plot for trying new agricultural technologies, products and services before adoption by the community. We'd like for CARI to consider supporting this platform for replication at the LGA level of this pilot.

    - Bring in partners to play in different chains (especially contract farming)

    - Continuous GAP training for ALL farmers at the hub using the proven train-the-trainer model.

    - Sponsor a permanent demo plot at the hub for testing new farming methods and technologies, allowing for open and transparent demonstration plus the opportunity to induct new farmers into GAP and FBS.

PHOTO GALLERY

Training 1 of 3, Argungu, Kebbi, Nigeria on 21st and 22nd Jan 2021. R-L: Lawal Ahmed (*KARDA*), Alhassan Sani (*EA, Argungu, Kebbi*), Hassan Tata (*EA, Argungu, Kebbi*), Olusegun Adegun (*Rural Farmers Hub*), Abdulmalik Alhassan (*Farmer/undergraduate, Argungu, Kebbi*), and Gabriel Eze (*Rural Farmers Hub*)

Stakeholder engagement meetings with farmers and EAs under Green Sahel in Gumel, Jigawa, Nigeria on 25th January, 2021.

Stakeholder engagement meetings with farmers and EAs under Atafi Agro in Hadejia, Jigawa, Nigeria on 26th January, 2021.

(Left) Extension agent, Aisha Abbas, during training on Climate-smart Agriculture on 8th August, 2021. Training manual on Remote Extension Delivery & mobile app installed in android phone on the desk for a hands-on experience. **(Right)** Consultative meeting between the directors of GSARDI (Muhammad Adamu), Atafi Agro (Muhammad Auwal), and Rural Farmers Hub (Olusegun Adegun & Gabriel Eze) on 24 January, 2021 at Green Sahel office, Gumel.

Training 2 of 3 for EAs at Gumel, Jigawa on 20th April, 2021. L-R: Halima Abdullahi (*EA, Gumel, Jigawa*), Abdulumar Danzomo (*EA, Gumel, Jigawa*), Suleiman Umar Adamu (*EA, Gumel, Jigawa*), Staff of Green Sahel, and Gabriel Eze (*Rural Farmers Hub*)

Field trial of digital solution in Jigawa held at Gumel, Nigeria on 20th April, 2021 .

Training 3 of 3 for EAs in Jigawa held at Hadeji, Nigeria on 8th August, 2021. L-R: Ahmad Ya'u Ahmad (*EA, Hadejia, Jigawa*), Abdulumar Danzomo (*EA, Gumel, Jigawa*), Aisha Abbas (*EA, Hadejia, Jigawa*), Halima Abdullahi (*EA, Gumel, Jigawa*), and Haruna Saleh (*Green Sahel*)