

2021 Pilot of Capture: Crop Watch and Weather Analytics for smallholder farmers in Kano & Kaduna Nigeria

1. Background

The Global Programme Green Innovation Centers for Agriculture and the Food Sector (GIAE) is part of the **"ONE WORLD No Hunger"** initiative in Nigeria whose objective includes driving innovations in the agriculture and food sector in rural areas towards contributing to sustainable rural development. For this pilot program, GIAE is exploring a digital extension tool called Capture in the maize value chain for its innovation potential in the specific market system.

Access to information and knowledge is a major driver for improving farming practises; however, the limited numbers of public extension workers in Sub-Saharan Africa mean that farmers often have 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 sector, 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 Competitive African Rice Initiative (CARI), this pilot exploration aims to address the challenges highlighted above through a combination of remote sensing and other digital technologies to deliver personalised agronomic advice to farmers remotely (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) were trained on how to use digital solutions to evaluate the viability of a farm and generate reports for mitigating risks for each farmer.
- Crop health monitoring: EAs were 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 and deliverables of the pilot

The program piloted two digital solutions, crop watch & analytics and weather analytics, towards providing personalised agronomic advice to farmers remotely. On the premise that new digital agriculture technology can increase smallholders' productivity in sustainable ways, hence the objective below:

2.1 Objectives

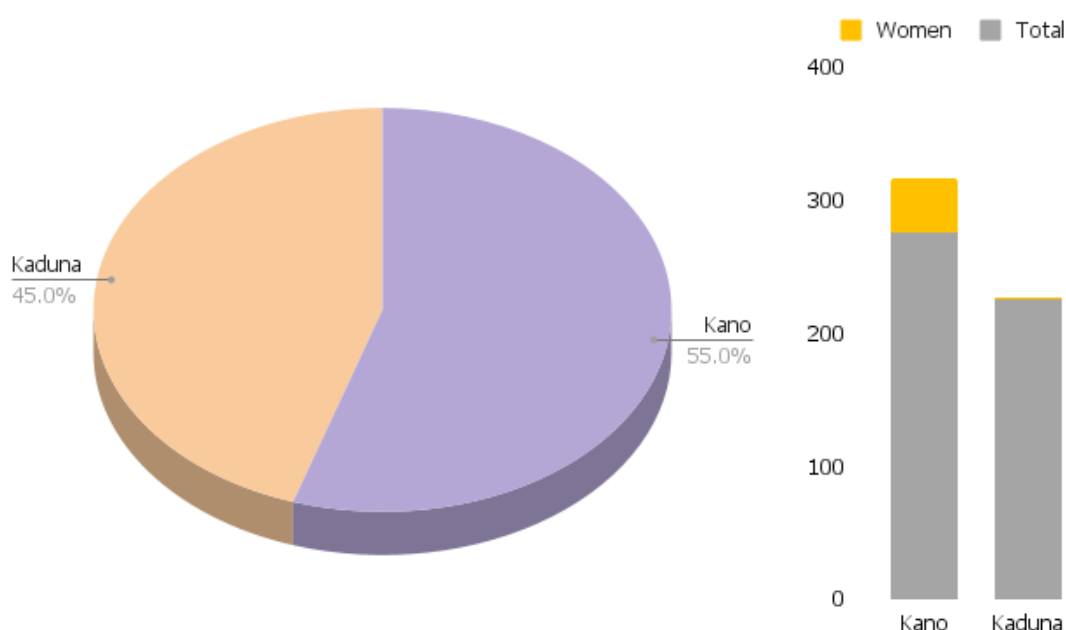
- To find out to which extent digital extension tools, i.e., crop watch & analytics and weather analytics can increase smallholder farmer's productivity and income in the maize value chain.
- To examine if digital tools can help mitigate productivity risk associated with weather.
- To find out if access to climate smart technology can help build farmers' resilience against climate change.
- To measure the sustainability and scalability of the business model.

2.2 Expected Deliverables

- Evidence of baseline study conducted
- Signed Letter of Intent with CARI MF Partners and GIAE Agro Input Dealers
- Activity implementation report, including lessons learnt during pilot, monitoring and evaluation reports and critical reflection on farmers' feedback
- Conducted a crop cut to measure the percentage change in yield of participating farmers
- Evidence that 1,000 smallholder farmers were geo referenced on Capture
- Further evidence must be provided that these farmers are in a contracting arrangement with the agro input provider that CARI/GIAE works with
- Further evidence must be provided that these farmers were previously trained in GAP/FBS

3. Tasks/Activities

The solution provider geo-referenced 500 smallholder farmers that GIAE works with in Kano and Kaduna states, particularly the farmers that have been trained on Good Agricultural Practices (GAP) by the Green Innovation Centre. 275 (55%) of the farmers were drawn from Kano while the remaining 225 (45%) were drawn from Kaduna. Only 44 (or 13%) of the participating farmers are women, 42 of 44 women are from Kano state; age distribution was not captured.



Although Kano has 50% representation of women at the extension agent level, it did not positively influence the number of women farmers onboarded for the pilot. This was due in part from the list of farmers provided by GIZ - GIAE.

3.1 Estimated Timeline

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

3.2 Tasks

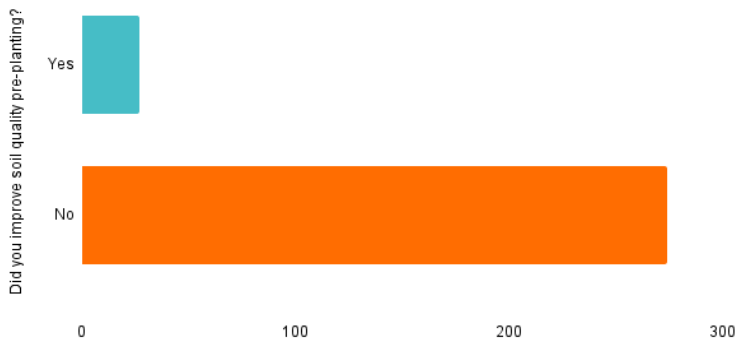
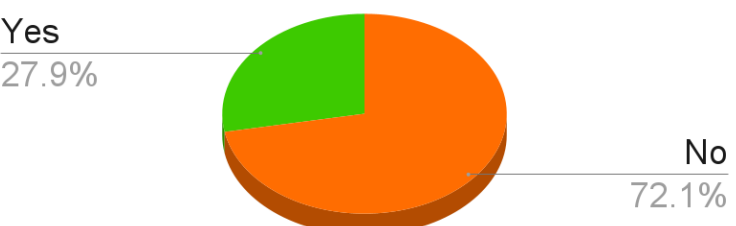
To achieve the objectives, the consultant is expected to fulfil the following task:

#	Activity	Period	Status	Update on Activities (Narrative)
1	Community sensitization	Jan 27 to Jan 30	Completed	<p>We held stakeholder engagement meetings with farmers, extension agents and staff members of GIAE in Kano and Kaduna states on the 27th, 28th, and 30th January 2021.</p> <ul style="list-style-type: none"> • Karaye event - 27th January, 2021 • Kura event - 28th January, 2021 • Makarfi event - 30th January, 2021 <p>All events were held at the respective local government secretariat except for Kura where we rented a hall at the Islamic Centre in Kura for the event. Fifteen (15) farmers from each of</p>

				<p>the seven (7) LGAs were in attendance across both states, bringing the tally to 105 farmers in attendance for the sensitization event.</p> <p>The meeting began with opening prayers that was followed by a round of introductions by all attendees. Gabriel Eze of Rural Farmers Hub kicked-off with a presentation on precision farming and other technologies for farming. He highlighted an alarming crop productivity data which is that smallholders today are producing less food per hectare than they did 30 years ago. Reasons for this decline include over-cultivation of land without rotation that may have led to severe soil damage; 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 vulnerability 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.</p>
2	Recruitment and registration of EAs	n/a	Completed	The assessment, selection, and recruitment of seven (7) extension agents was supervised by the GIZ team and her other partner(s). This activity was completed.
3	Training for EAs on Remote Extension Delivery (RED) with Simulated field experience on a demo plot	Mar 3 to Mar 4	Completed	<p>This training (2 of 3) took place at Karaye LG secretariat and KNARDA office in Kano city on May 3rd and 4th 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.</p> <p>Sequel to training 1 of 2, 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. Also, the initial training in January 27th to 30th was inadequate as 5 out of 7 EAs struggled to follow through the defined workstream. For commendation sake, the EAs that excelled from that first training were Aisha Maiwada Ahmad and Mustapha Ismail Yola both of Kano state. Looking back, we should've attempted to recruit both of them to retrain the rest; however, considering they were strong proponents of the retraining (training 3 of 3) that later took place in Zaria on 13th July 2021, their capacity was inadequate to carry out such stepped down training at the time.</p>
4	Training for EAs on Mapping and networking of farmland and	Jan 27 to Jan 30	Completed	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, we gave them a deep-dive into precision

	related assets (Geo-referencing)			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 the 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 we closed the session.
5	Selection and interview of 500 farmers	n/a	Completed	After training 1 of 3, extension agents embarked on the selection process of farmers who participated in the pilot; the baseline criteria is that they must be smallholder farmers and there must be gender balance. This process was supervised by the GIAE team and the Agricultural Development Programme (ADPs).
6	Baseline survey of 500 participating farmers		Completed	See section 4 below for details.
7	Geo-referencing/Mapping of 500 farms	Feb 10 to May 5	Completed	479 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.
8	Geo-referencing/Mapping of agro input dealers and other relevant stakeholders (GIZ/GIAE handles the selection process)	Feb 10 to May 5	Skipped	<p>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.</p> <p>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.</p>
9	Training for selected/participating agro input dealers and other relevant stakeholders	n/a	Skipped	<p>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.</p> <p>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.</p>

10	Training for the GIZ GIAE team	Apr 13	Completed	<p>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.</p> <p>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.</p>
11	Processing/clean-up of geo-referenced data	Mar 1 to May 30	Completed	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.
12	Actual field trials for/by EAs	Mar 3-4	Completed	This activity was carried out alongside training 2 of 3
13	Step-down training for farmers by EAs	Mar 3 to date	Completed	<p>Extension agents meet with farmers periodically to step-down the training received as a result of this project. Modules include;</p> <ul style="list-style-type: none"> ● Improving soil quality ● Variable rate application of farm inputs (seed, fertiliser, pesticides, etc) ● Seed rate (during planting) ● Fertilisation program <p>In addition to the GAP, this pilot introduces new methodologies that require some behavioral 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.</p>

				<p>Farmers who improved soil quality before planting</p>  <p>For example, we required the farmer to test for soil pH and carbon content pre-planting; where there are deficiency, they are to apply liming material or mulch as the case may be, and on the contrary, not do any of those. Some farmers are already applying liming material pre-planting which may be deteriorating to soil condition. Getting them to make this change was problematic.</p> <p>Farmers that followed fertilizer program</p>  <p>Another case was the 7-step fertiliser program, a change that was strongly opposed at first by the farmers in Danayamaka, Kaduna state. With continuous weekly meetings, minds began to turn gradually.</p> <p>This new fertiliser program was counter-intuitive for the farmers coupled with the additional labour cost it will impose on them; applying fertiliser twice is already a burden, asking them to apply 7 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.</p>
14	Go live (planting window)	Jun 7 to Jul 15	Completed	EA set the planting date for each farm to enable the digital correctly calibrate and determine the right advisory for each farm per time.
15	Monitoring & evaluation	Jul to Nov	Completed	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.
16	Submission of final report (harvest data gathering precedes this activity)	Dec 2021	Completed	Attached herewith

	Unplanned Activity		Status	Narrative
	Retraining exercise for extension agents in Zaria	Jul 13	Completed	Following the initial training, it is clear that participating EAs understand the core of the pilot program which is precision farmer. It helps farmers manage yield expectations, optimise farm input, lower the cost of production, and general improvement at the micro level. What is also clear is that most EAs do not understand their role in bringing it to their farmers effectively nullifying the first training (perhaps inadequate at best); the follow-up exchanges on WhatsApp was not enough to get them started. Because the program is not familiar, this is understandable; however, what is disappointing is the affected EAs not bringing this to the notice of RFH. As at the start of this retraining exercise, only Aisha Maiwada (Dakasoye axis) and Mustapha Yola (Rogo axis) are using Capture to advise their farmers albeit sub-optimally.
	Monitoring & evaluation (Weekly check-in virtual call)	Jul 9 to End	Completed	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 our 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		Completed	Extension agents were mandated to hold weekly meetings with farmers and bring reports of the outcome of such meetings to the weekly check-in session (Google Meet). Following the retraining of EAs in Zaria on July 13, 2021, we held a weekly check-in session via Google Meet every Tuesday from 5-6pm. The meeting agenda is as follows: <ul style="list-style-type: none"> - Share progress report on setting planting date - Update on educating farmers on the nutrient program proposed under this pilot - Update on group meeting with farmers - Update on Baseline and other surveys
Kano-specific Progress				

	Banditry	Banditry activity in Bari and Rogo as reported by EA Mustapha Ismail Yola; weekly farmer meetings are not held as a result. However, farmers still visit their farm scared for their safety and the stepped down training was received, understood, and partly applied by the farmer before this incident escalated.
Kaduna-specific Progress		
	Flash flooding	<ul style="list-style-type: none"> As a result of heavy rain on 13/08/201, there was a heavy flood incident in some communities in Makarfi LGA (Hayin gada, Anguwar kanawa and Bazana all in Gubuchi). It resulted in damages of houses and crops; more than 60 houses collapsed from this flood impact. Through the effort of Yahuza Abdullahi (EA, Makarfi, Kaduna), we tracked the points of impact for further research on improving detection of such incidents: <ol style="list-style-type: none"> Hayin Gada, Gubuchi (Lat: 11.2442737, Lng: 8.017460800000001) Anguwar Kanawa, Gubuchi (Lat: 11.264356, Lng: 8.009666500000009) None of our farmers were affected by this flood incident. Flood detection was not a part of the scope of the pilot under review. EA Nasiru had a series of personal issues (health, and others) that led to his inability to carry out his duty. This situation was identified quite late as his number was not reachable during his absence from duty; also, his colleagues did not report that they were aware of his situation during weekly meetings.

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)

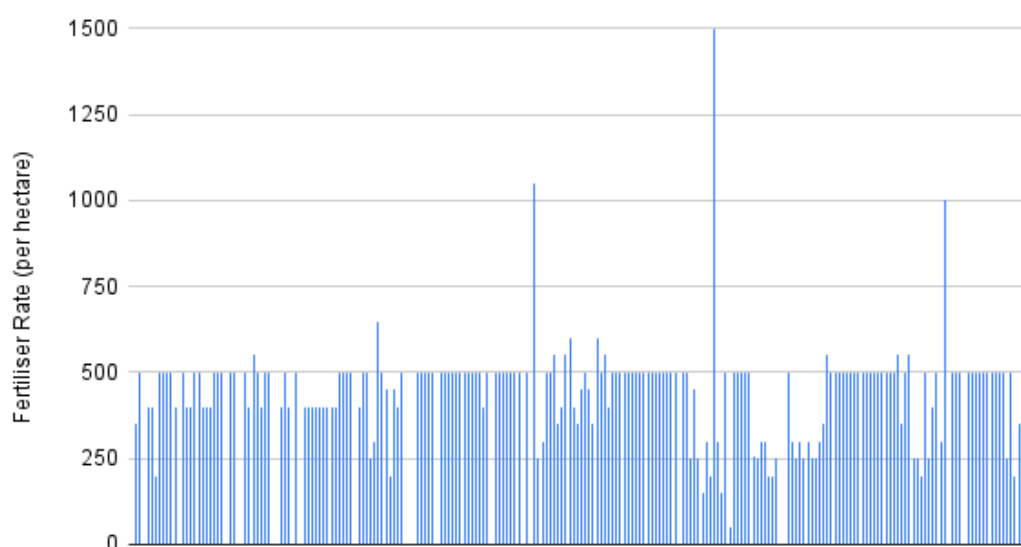
5. Baseline Survey

We interviewed 241 maize farmers (men: 210, women: 31 || Kano: 133, Kaduna: 108) who participated in this pilot. Our goal is to get a sense of their situation in the previous (2020) cropping calendar and use such a baseline for analysis. Here are what we found:

- Baseline survey sample size is n=241
- A majority of the maize farmers surveyed (56%) don't have a history of using digital tool(s) for farming in the previous farming season.
 - For farmers who don't have a history of using digital tools, the primary reason for this is distributed between (a) lack of awareness—43%, (b) low ICT literacy level—26%, and (c) not having/owning a smartphone—19%.
 - For farmers who have used digital tools, they indicated Digital Advisory Services and e-Extension Services as examples with the weight leaning heavily to the first two—87 of 97 responses. Further inquiry revealed that the majority of the farmers were actually referring to the Capture application under pilot, leaving us with Digital Financial Service as their only prior history with digital tools.
- 60% of farmers do not carry out soil nutrient and other properties analysis before planting; as a result, the amount of fertiliser used was not determined by some ground-truth data. However, about 70% of farmers agree that such analysis is important and does have consequences on the farm's outcome; 30% disagrees. High cost of conducting such laboratory analysis just in time before cultivation is the major hindrance. There is a demand-supply issue arising from a very limited number of such laboratories which are within reasonable proximity to the farmer.
- About 171 of 231 farmers acknowledge that weather information is an important metric for farming decisions, particularly for such farming activities as optimal timing for planting and fertiliser application in that order.

- The average fertiliser application rate is 400 kilograms per hectare; this is 1.6 times above the government's generalised recommended minimum of 250 kilograms per hectare. Land size is a major determinant of the amount of fertiliser to use by farmers surveyed; but there is a growing uptick (18%) in the use of expected yield as a determinant.
 - 13 of 219 of the respondents used more than 500 kilograms of fertiliser per hectare (representing ~6% of the farmers); this is indicative of over-supply of fertiliser to the soil.
 - Only 7.3% 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.

Amount of Fertiliser used per Hectare in 2020



- There's an URGENT need for better fertiliser management by farmers in Kano and Kaduna state. It would seem the farmers are oversupplying fertiliser to the crop at the wrong time and least optimal condition. There are concerns of low utilisation of such fertiliser by crop as well as water-related pandemics in the community and environs if this risky practice is not checked.
- 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; only 4 respondents say they use digital tools for disease detection and diagnosis.
- The farmers are fairly split evenly between their reasons for engaging farming – subsistence and commercial alike.
- Majority of farmers don't earn a living wage from farming alone, 89% of them say they are engaged in other non-farming activities to earn supplemental income.
- The average yield for maize for the sample data was **2.39 MT** in the 2020 cropping calendar.
- The maximum yield (2020) was 10 MT while the minimum yield (2020) was 0.1 MT.

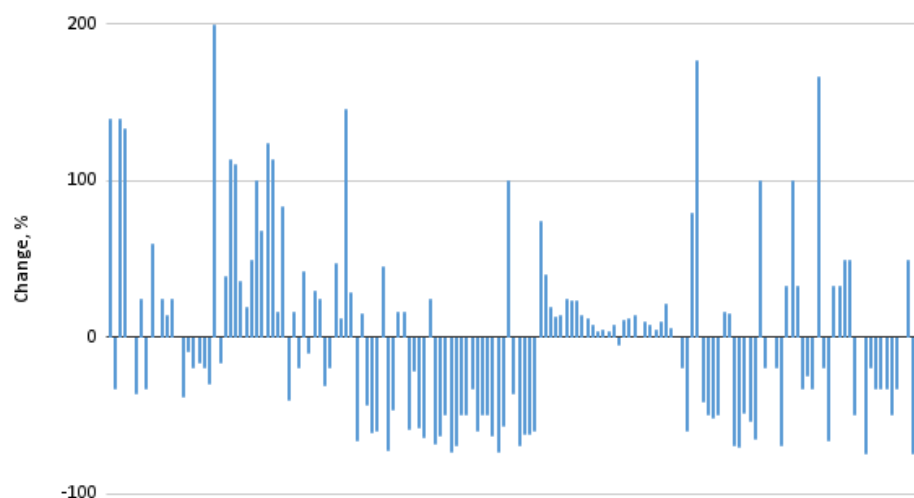
- It is estimated that the cost of **visiting a farmer per day** could be as high as N2,500 because most of the farmers live and farms are far apart in remote villages which are time-consuming and expensive to visit. Sequel to the above, there's also a limit to the number of farmers that can receive a personalised session with the agent in a month.

6. Endline Survey Findings (Results)

At the end / after harvest, we were able to interview 343 maize farmers who participated in the 2021 cropping calendar (wet season) for the pilot under review. Our goal is to find out how the intervention with the aforementioned digital solutions impacted them. Here are what we found:

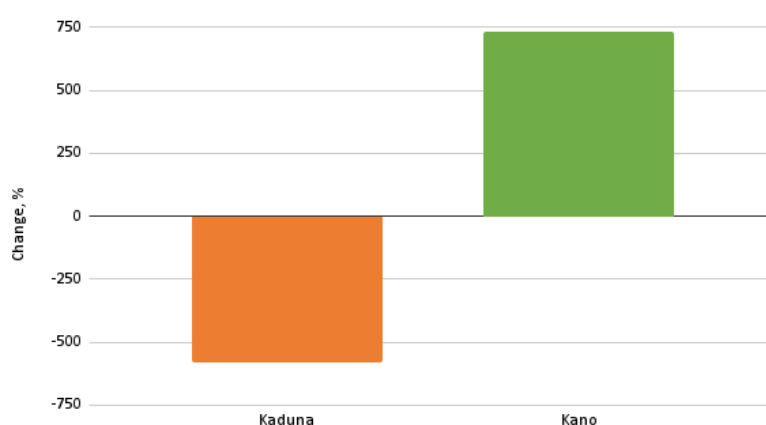
- Endline survey sample size is n=343 (a count of unique survey respondent)
 - Average farm size is 0.41 hectare. Total maize output is 860.95 metric-tonne (MT) from a total cultivated area of 149.09 hectare (ha).
 - The job of seven (7) extension agents was improved to include advisory on climate-smart farming. Two (2) of them are women and both of them were recruited from Kano state representing one-third of the employment distribution; there were no woman extension agents recruited for Kaduna state.
 - For the 2021 cropping calendar under review in this pilot, the **average yield change**¹ per farmer is **25.90%** (year-on-year). This means more farmers experienced yield increase around a rate of 25% compared to the previous year.
 - The average yield for the 343 farmer group surveyed increased from 2.39 MT in 2020 to 2.51 MT in 2021, a **relative change**² of 5.10%.
- ¹ This is calculated by first determining the % change for each farmer, then the sum of the % change divided by the number of farmers.
- ² Also referred to as 'Relative Change or *Relative Difference*' is a comparison of the average yield in 2020 and 2021 expressed as a ratio of the average yield for 2020.
- The maximum yield (2021) was 10 MT while the minimum yield (2020) was 0.3 MT.

Yield Change, % (from 2020 to 2021)



Although the average yield change y-o-y of 25.90% is less than the projected 30% increase, there are some interesting positive layers of data to what we've found:

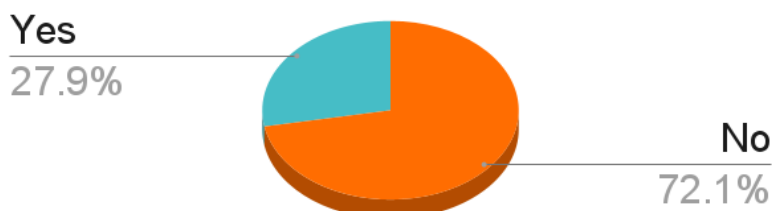
- The ratio of farmers who saw a positive yield change versus negative change is split 260:68; the yield of 15 farmers did not change during the period under review.. In other words, for every 1 farmer that had a negative result, there were 4 farmers that had a positive outcome.
- Total yield gained (+11,990%) outweighs the total loss (-3,106%).
- The weight of % yield increase far outweighs the weight of % yield loss.



- When you zoom into the yield change data by state, you will notice that the aggregate negative effect on yield is coming from Kaduna state (see chart above). While Kano farmers prospered, the farmers in Kaduna did not. From the report we get during the weekly check-in sessions, it is apparent that the

majority of farmers did not adhere to the standard operating procedure of this pilot as advertised and agreed upon.

Farmers who followed the 7-step Fertiliser Program



- Only about a quarter of the farmers in both Kano and Kaduna followed the 7-step fertiliser application recommendation; the reason for this was highlighted in the earlier section of this report.
 - Nearly 90% of them did not improve soil quality before planting.
 - Presenting these data to the farmers in the coming year may result in a better outcome in terms of reception and adoption of some of these methodologies in the upcoming season. It is our expectation that the farmers will see the consequence of their inactions.
- 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 65 where every farmer is visited at least once per week or at least 4 times per month; as a result, the monthly unit cost of service provision per farmer is N203 (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 or car), 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 65 farmers, that will amount to an average of N146,250 per month to serve all 65 farmers.

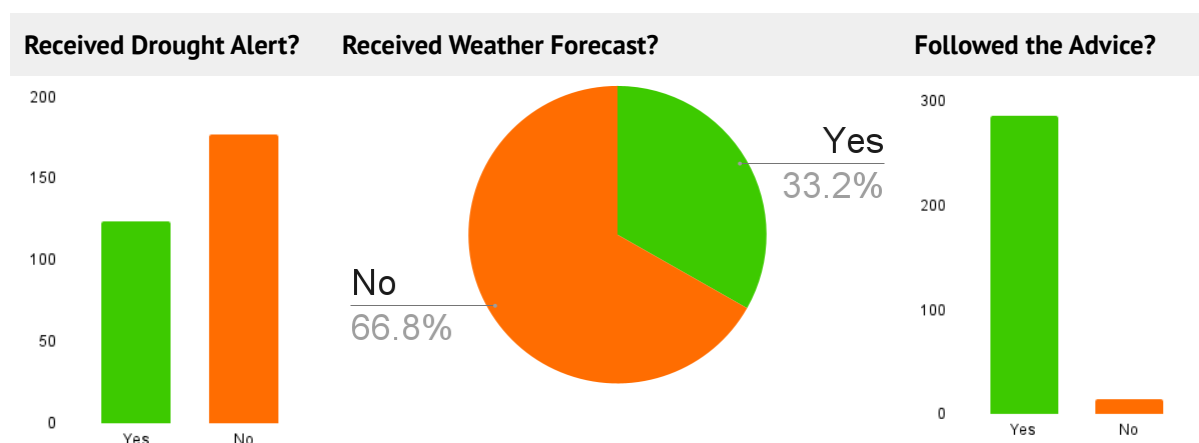
	Pilot Approach <i>(Weekly check-in & Capture app)</i>	Legacy Approach <i>(Monthly check-in on farm)</i>
Monthly Unit Cost (per farmer)	N203	N2,250

Annual Unit Cost (per farmer)	N2,436	N27,000
<i>* Excluding software licensing/subscription costs</i>		

- 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 (per hectare) will be N12,436 which is 54% cheaper than the legacy approach.
- Our findings show that additional N56, 100 (average) in new income is gained by the farmer after the pilot. Spending N12,000 to get an extra N56,000 seems like a good business; and this is not even the optimal outcome. 211 of 230 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.
- Going by the average farm size of the farmers is 0.43 hectare, the actual service fee payable by a farmer is about N4,300 per year or ~N350 per month.
- 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 approach.
- In order to determine if the digital tool under review helped mitigate productivity risk associated with weather, it is important to measure the sense of adoption of the advisory, especially as there was initial resistance to some behavioural changes demanded by the use of the tool.

Analysis of the responses showed that more farmers did not receive drought alerts or weather forecasts. For the former, our initial deduction is that drought was not expected in those locations; however, it could also be that they have changed phone numbers or they have “Do Not Disturb” enabled on their line. To make up for such shortfall, EAs used the weekly check-in meetings with farmers to provide the same face-to-face.

Generally, most farmers who received weather advice actually applied it. When compared to the poor adoption rate of the fertilisation program as recommended by the pilot, farmers were already familiar, accepted, and are using weather to make farming decisions; 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 for them; however, farmer Mikailu and others in parts of Kura (Kano) were most affected by the drought. A resilience mechanism could've been to partially irrigate the affected maize farms during the spell but for the absence of irrigation and borehole.

- Coming into this pilot, about 60% of the farmers said they did not have prior experience using digital tools for farmers. This might also explain some of the hesitation in adopting it. However, 211 of 230 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. What is encouraging is that, despite not accepting some of the new methodology shared, a majority of the farmers attended the weekly check-in sessions with EAs. In 4 states in the northeast of Nigeria, over 1,500 farmers are paying a fee to receive an “integrated/inclusive” and personalised digital advisory service from Rural Farmers Hub through our network of extension agents and retailers across the state. A similar model can be replicated by this project.

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	link

	with crop cut methodology prior to writing this report.	
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


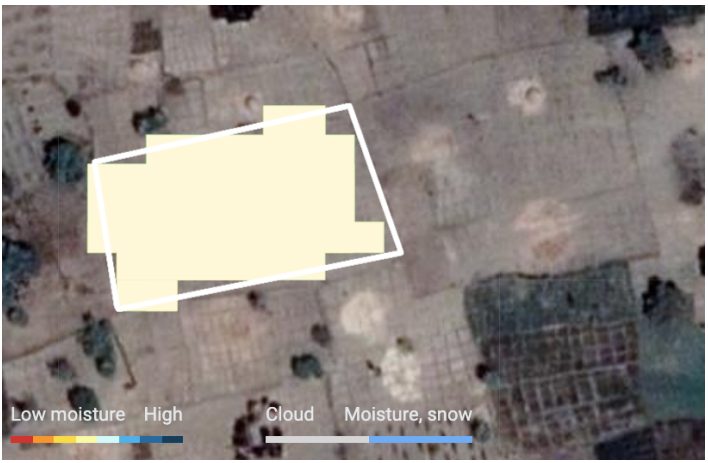
- Some of the climate-smart methods introduced to the EAs were too advanced for their current stage of learning. Particularly, Growing Degree Days (GDD), a weather-based performance metric for monitoring crop development. It is a measure of heat accumulation used to predict plant and pest development rates until it reaches maturity.
- Majority of the farmers, particularly in Kaduna, were hesitant to follow our recommended fertiliser program to the letter. All 55 respondents as at the time of submitting this report stated they applied a maximum of 3 out of the 7 times they were advised to apply at varying rates. The common reason is that this is counterintuitive and new to them.
- 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). The good news is that there are so many mid-end android phones that come with the capability; the price difference between current devices is N10,000 to N20,000. EA needs to research the phone specification in order to determine its suitability for GIS-related agricultural applications before purchase.
- 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 higher 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.

8. Opportunities/Recommendation

- The recruitment process for farmers and extension agents who are to perform precision advisory needs to be re-evaluated.
- Sequel to the above challenge, there's a case to be made for a different training approach (extended hands-on training on the use of ICT tools) towards improving the productivity of extension agents on the recent advances in the agricultural sector, especially precision agriculture, climate-smart agriculture (CSA) and agriculture-related weather concepts which can be helpful in supporting farmers towards improving their and crop's productivity. The agents will be able to train the farmers under their portfolio to be self-dependent in understanding and applying CSA advice when provided;
- 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. These candidates can then be embedded into the ADP in secondment where they function as "***Extension Agent in Residence***" (EAiR or EAR);
- Mobile apps will not replace human extension agents, 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 would like for GIAE to consider supporting this platform for replication at the LGA level where this pilot took place. Here are proposed areas of support:
 - 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.

- The recruitment process for extension agents needs to be reviewed for future similar assignments. Kano state had a more efficient and productive EAs than Kaduna partly due to hiring the right kind of (and qualified) EAs for this project. The hiring in Kaduna, regrettably, was not done well and is reflected in the performance of the EAs and farmers alike.
- There's an URGENT need for better fertiliser management by farmers in Kano and Kaduna state. It would seem the farmers are oversupplying fertiliser to the crop at the wrong time and least optimal condition. There's a concern of a water-related pandemic in the community and environs if this risky practice is not checked.
- A personal testimonial: EA Aishat Maiwada carried out a personal trial with the digital tool on her rice farm (outside the pilot project)

ANNEX

<i>Sample weather forecast</i>	ROGO: High chance of rain on Friday, SAT and MON.
	KURA: There is a high chance of rain today, tomorrow, SAT and MON.
<i>Sample drought alert</i>	DRY SPELL: Most mild dryness starting late JUL to mid-AUG. It will last 10 days but might as well extend to a total of 20 days. Normal rainfall should resume in the last week of Aug
<i>Optimal planting window alert</i>	Note that the best time for rice & maize farming this dry season is JAN ending or early FEB. Both crops require warm weather to do well. Planting during harmattan costs more money and leads to low yield.
<i>Climate alert</i>	<p>DRY CONDITION ALERT!</p> <p>There's a BIG anomaly in the weather pattern this year (due to climate change) causing dryness that may last into July, it may correct in the next few weeks; brace up for the worse. Get good seed variety with shorter maturity as rain may recede early. Also use bunds for rice for efficient water use.</p>
<i>Crop health monitoring</i>	
<i>Water stress</i>	

Remote nutrient evaluation



Result



High Risk and Not Viable

Soil fertility is extremely low; as a result, farm is not viable. Investment in fertilizer application without improving soil quality may amount to waste. Method for improving quality requires a lot of patience by fallowing, followed by organic incorporation

Fertility



Expected Yield per Hectare

10  MT

Nutrient required

16.54 Kg 49.63 Kg 8.82 Kg

Area

0.17 Ha 0.17 Ha 0.18 Ha

[Download Fertility Map](#)

* For GPS-guided drone application

Soil quality assessment

Soil Composition



Checked 10 Jul, 01:07pm

Weakly acidic

Soil is slightly acidic and okay for most crops. However, it also means that you are advised against applying things like ash and other acid neutralising products.



Clay
Silt
Sand

pH Level
6.1Carbon Content
7Organic Matter
12.04Applied? YES  NO 

PHOTO GALLERY



Training 3 of 3, Zaria, Kaduna, Nigeria on 13th July 2021. L-R: Mohammed Ubale (AFCI), Gabriel Eze (Rural Farmers Hub), Nasiru Abdullahi (EA, Kaduna), Aishat A. Maiwada (EA, Kano), Yahuza Abdullahi (EA, Kaduna), Dahiru Babbaye (EA, Kaduna), and Mustapha Ismail Yola (EA, Kano)



Stakeholder engagement meetings with farmers, EA and GIAE staff in Makarfi, Kaduna, Nigeria on 30th January, 2021.



Stakeholder engagement meetings with farmers, EA and GIAE staff in Kura, Kano, Nigeria on 28th January, 2021. Far-right is Binta Shuaibu (EA, Kura, Kano) and Olusegun Adegun (Rural Farmers Hub) behind



Stakeholder engagement meetings with farmers (they had left before the photo op), EA and GIAE staff in Karaye, Kano, Nigeria on 28th January, 2021. L-R: Farmer, Olusegun Adegun (Rural Farmers Hub), Aliyu Bin Hashim (EA, Karaye, Kano), Gabriel Eze (Rural Farmers Hub), Mustapha Ismail Yola (EA, Rogo, Kano), and Mohammed Ubale (AFCI)

S/N	NAME	PHONE No.	GROUP	S
1	LAWAN USMAN	08069767655	KARAYE FADAMA	
2	GARBA S/ADMA	07033274001	"	
3	SULEMAN MOHD	08069288015	"	
4	MUSTAFA MOHD	08068979477	"	
5	IBRAHIM HAMZA	08062595251	"	
6	AMINU ABDULLAH BADERI	08033325458	DEDEZI GAKI HUMANIA F.	
7	ALIYO MUHAMMAD	0806952476	"	
8	IMYASU MUHAMMAD YAU	08065391449	"	
9	GHASIM ALIYU DEGERI	08067252927	"	
10	AMALAZU JUDA DEGERI	08065926588	"	
11	MUHAMMAD TELA	07032693338	KARAYE FADAMA	
12	MAL. YAU KARIMATA	08147489278	"	
13	SALI TELA	09033115472	"	
14	MAMMAN GAMBO	08064581965	"	
15	NASIRU DANIGABA	08060364440	"	
16	YANU A. YAU	07014293040	KARAYE FADAMA	

S/N	NAME	PHONE No.	GROUP	S
1	BADMASI DAKIRU	08107320221	ZOZA MAIZE PROD	
2	ISAJAKU MUHAMMED	08141971922	"	
3	DALHA ABDU	08022323533	"	
4	NAZIRU IBRAHIM	0806767477	"	
5	A GARBA UMAR	08035221924	"	
6	SULEMAN A. ISA	08141868774	ROGO NIIMA	
7	SALI ADAMU HAMISU	08166186645	ROGO NIIMA	
8	SURJO UMAR ADO	08053737819	ROGO NIIMA	
9	MAYAM ISYAKU	08028063573	ROGO NIIMA	
10	SHARBU SULE	08084146226	ROGO NIIMA	
11	FATIMA SAMATLA	09068954571	GIDNAT WATO W FADAMA	
12	GAGE MAHMMAN	07089337615	"	
13	GHUMMAN DANGUMMA	07031235670	"	
14	RAKIYA GAMBO	08038610578	"	
15	AISHA SAMI	07066870123	"	

Farmer attendance list during engagement in Karaye, Kano, Nigeria on 27th January, 2021. L-R:
Attendance for Karaye farmer group, Attendance for Rogo farmer groups