BILL & MELINDA GATES foundation

# Progress Narrative

*Use this form to provide updates to your foundation program officer regarding progress made toward achieving your project's stated outputs and outcomes.*

*The Progress Narrative must be submitted in Word, as PDFs will not be accepted.*

## General Information

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| **Investment Title** | ACAI: African Cassava Agronomy Initiative | | |
| **Grantee/Vendor** | International Institute of Tropical Agriculture | | |
| **Primary Contact** | Bernard Vanlauwe | **Investment Start Date** | September 28, 2015 |
| **Feedback Contact**[1] | Bernard Vanlauwe | **Investment End Date** | December 31, 2020 |
| **Feedback Email**[1] | B.Vanlauwe@cgiar.org | **Reporting Period Start Date** | January 1, 2018 |
| **Program Officer** | Christian Witt | **Reporting Period End Date** | December 31, 2018 |
| **Program Coordinator** | Jeanne Bridgman | **Reporting Due Date** | February 15, 2019 |
| **Investment Total** | $16,394,457.00 | **Opportunity/Contract ID** | OPP1130649 |
| **Scheduled Payment Amount** (If applicable) | $3,318,452.00 | | |

[1] Feedback Contact/Email: The full name and email of the contact whom foundation staff queries for various surveys.

## Submission Information

*By submitting this report, I declare that I am authorized to certify, on behalf of the grantee or vendor identified on page 1, that I have examined the following statements and related attachments, and that to the best of my knowledge, they are true, correct and complete. I hereby also confirm that the grantee or vendor identified on page 1 has complied with all of the terms and conditions of the Grant Agreement or Contract for Services, as applicable, including but not limited to the clauses contained therein regarding Use of Funds, Anti-Terrorism, Subgrants and Subcontracts, and Regulated Activities.*

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| **Date Submitted** | [February 15, 2019] | **Submitted by Contact Name** | Dr Liavoga Allan |
| | | **Submitted by Contact Title** | Head, Project Dev. & Admin Unit |
| | | **Submitted by Contact Email** | A.Liavoga@cgiar.org |
| | | **Submitted by Contact Phone** | +234 039 7840491 |

# Progress and Results

## 1. Progress Details

**Provide information regarding the current period's progress toward achieving the investment outputs and outcomes as well as the work planned or anticipated for the next period. In addition, submit the Results Tracker with actual results as requested.**

## Introduction and summary

The African Cassava Agronomy Initiative (ACAI) aims at improving cassava root yield and quality, and cassava supply to the processing sector. This change is expected to be achieved through effective partnerships with development partners in Nigeria and Tanzania, supported by national agricultural research systems (NARS). ACAI will engage over 120,000 households in Nigeria and Tanzania including at least 30% women farmers and leading to the creation of over US$28 million.

The ACAI project is formulated around six “use cases” that were prioritized during project formulation with stakeholders actively engaged in cassava value chain activities. These use cases are specific sets of information on improved cassava agronomic practices, and their translation into tools and applications that are accessible to extension agents who provide recommendations to farmers and other beneficiaries. The six uses cases are:

(1) Site-specific fertilizer recommendations (FR) which provide nutrient management advice tailored to local soil conditions and crop calendars for sustainable cassava production intensification.

(2) Fertilizer blending (FB) which advises on appropriate fertilizer blends for cassava-producing geographical areas based on soil fertility conditions, cost of inputs, and potential demand.

(3) Best planting practices (PP) which guide farmers in choosing best-suited planting practices for cassava, with a focus on tillage operations and in close relation with improved weed control recommendations.

(4) Intercropping practices (IC) which recommend intensification options (planting density and arrangement, varietal choice, relative planting time, and fertilizer application) in cassava-based intercropping systems.

(5) Scheduled planting (SP), which provides recommendations on scheduled planting and harvest dates to ensure a more continuous supply of fresh cassava roots to the processing industry.

(6) High starch content (HS), which recommends agronomic practices to optimize starch yields for cassava growers supplying the processing industry.

The development and delivery of these use cases and the facilitation of their use happens through six Work Streams (WS) that form the structure of ACAI. These WS are:

(1) Research on cassava growth dynamics, nutrient and water requirements, and responsiveness to inputs.

(2) Development of a geospatial cassava agronomy information base.

(3) Production and validation of demand-driven decision support tools (DSTs) for cassava agronomy.

(4) Facilitation of the use of decision support tools (DSTs) to primary and other development initiatives.

(5) Capacity development of national institutions to engage in transformative cassava agronomy R4D.

(6) Project governance, management, coordination, and monitoring, evaluation and learning (ME&L).

This report presents activities and achievements of the project in 2018, the third project year. The report is organized around the six WS of the project and the deliverables under the various outputs of the project during this period. Key accomplishments during this period include:

(1) Harvest of the second season of field trials completed and all necessary data obtained to validate and improve the V1 DSTs, as well as delivery of the baseline study with detailed information on over > 3200 cassava fields, including yield assessments to further guide the development of the DSTs

(2) Improvements to the modelling frameworks to provide more accurate site-specific recommendations for the various use cases, and procedures in place to validate V1 and produce V2 of the DSTs.

(3) Increased efficiency to compile GIS information and run geospatial models to extrapolate results from field trials and crop models across the target intervention areas, and develop recommendation domains.

(4) Operative improved V2 versions of the DSTs for each of the use cases available, built and cross-validated using results from at least two seasons of field testing, integrating the improved modelling frameworks and geospatial analyses, and packaged in various formats, including smartphone app, USSD/IVR and paper-based maps, tables, and decision trees.

(5) Strengthened primary partnerships, with effective collaboration in the field to conduct validation exercises in a pilot program with > 160 trained extension agents, evaluating the DST recommendations against farmers’ current practice in > 1200 on-farm side-by-side comparisons.

(6) Improvements to the data management system, producing standard reports on incoming data from trials and surveys, and supporting the supervision of the validation exercises.

(7) Preparations have started for the promotion and scaling of the DSTs, and more rigorous monitoring and evaluation of the uptake and use of the recommendations supplied through the DSTs.

(8) Capacity development activities (including PhD and MSc student projects) on track, with increased effort on independent and self-support uptake of techniques and learning within the NARS institutes.

  

Within each WS, specific activities contribute to the delivery of the knowledge and tools necessary for the realization of the outputs associated with each use case. This report presents outputs per WS and provides details on the progress made, as well as highlights challenges, next steps, and some of the opportunities identified. Details on the delivery against target milestones can be found in the Results Framework and Results Tracker.

## WS1: Research on cassava growth dynamics, nutrient and water requirements, and responsiveness to inputs

WS1 contributes to Intermediate Outcome (IO) 1.1 of the project: *By 2017, strategic research on cassava growth and nutrient requirements is integrated in the development of decision support tools for cassava intensification.* Activities of WS1 provide the necessary insights in the impact of agronomic practices on cassava yield and root quality, as well as the knowledge base to populate and calibrate the modelling frameworks underlying the DSTs. Most of the key deliverables for WS1 were delivered by the end of 2017, as foreseen. Some activities carry over into 2018, including the harvest of the second and third season of multilocational research trials, plant and soil sample analyses, and much of the modelling activities building onto the data generated through these trials.

**Output 1.1: A review of existing knowledge on cassava agronomy conducted and used to refine work plans of other activities in WS1**

We continued to digitize more literature (including published papers in scientific journals, annual project and research institute reports, unpublished datasets, books and book chapters, student theses, and conference papers). The database currently holds data from 201 studies covering 31 countries, with 78 experiments relevant to the FR/FB use cases, 53 for IC, 57 for PP, 40 for SP and 34 for HS. We use this database to guide field trial experimentation, parametrize crop models (QUEFTS, LINTUL and DSSAT), and answer ad hoc questions on cassava agronomy from within and outside the project. The ongoing meta-analysis consolidates the learnings for the individual use cases as stated in the 2017 report. We made progress writing up the review paper on the state-of-the-art of cassava agronomy, and plan to dedicate efforts to finalize and submit this to an international peer-reviewed journal in 2019.

**Output 1.2: Response curves for cassava monocrop systems described for the different agroecologies and soil types**

To date, a total of 736 nutrient omission trials have been set up across the planting window in 2016, 2017, and 2018. The harvest of the second season (227 trials) in Nigeria started in May and was finalized in September, as trials were established in the same period last year. In Tanzania, the harvest of the third season (290 trials) was completed by November in the Lake Zone and eastern part of the Coastal Zone, while harvest will start in January 2019 in the southern part of the Coastal Zone. A final set of 18 repeated trials were established in Nigeria in April–June 2018, mainly to collect additional data on nutrient accumulation to confirm and improve the calibration of nutrient-use efficiency in the QUEFTS modelling framework.

The analysis of the first year's trials revealed significant site-specific responses in N, P, and K, particularly in Nigeria. This was confirmed in the second season for Nigeria, and much more pronounced in Tanzania, where yields were generally higher due to better rainfall conditions. Largest yield reductions due to omission of N were observed both in Nigeria (–3.9 t/ha) and in Tanzania (–2.4 t/ha), followed by K (–3.3 t/ha in Nigeria and –1.2 t/ha in Tanzania). Only in Nigeria, an overall yield reduction due to omission of P was observed (–2.1 t/ha). These reductions varied substantially, with CVs exceeding 100% corroborating the need for site-specific fertilizer recommendations. These results expanded the dataset, providing more signal for the prediction models linking crop response with GIS-inferred soil properties, and comparing with directly measured soil information from soil samples collected in each of the trial locations. This dataset now provides the possibility to analyze to what extent site-specific responses to N, P, and K can be predicted based on soil parameters, and to what extent the accuracy of these predictions suffers from relying on inferred rather than directly measured soil information. This analysis forms part of a larger exercise to evaluate how these relationships differ between geographically distant areas, how predictions can be expanded beyond the current target intervention areas, and to what extent new nutrient response data is needed to do so. This exercise will be conducted once harvest data from the last set of trials is available in 2019.

**Output 1.3: Nutrient norms established, nutrient constraints assessed in the target regions**

A first set of draft norms has been successfully developed by one of ACAI's MSc students. To date, a total of 11 555 leaf samples have been collected from the nutrient omission trials (NOTs) and validation trials in Nigeria and Tanzania. About a third of these samples have been analyzed at the IITA and ICRAF labs for analysis of nutrient content using pXRF (a low-cost and fast analysis technique) and ICP-OES (for calibration and validation). Two methods were compared to develop the nutrient norms: Compositional Nutrient Diagnosis (CND) and Diagnosis and Recommendation Integrated System (DRIS), of which the former appeared to be slightly more robust. The norms clearly confirmed that N and P were the most deficient nutrients in Nigeria, contrary to K in Tanzania. The study also identified B and Zn deficiencies in specific cases.

Analysis of more samples is ongoing, particularly for the second round of NOTs, and will be linked to yield response data. Once robust nutrient norms are available, an analysis is planned to evaluate whether nutrient norms effectively improve the prediction of nutrient responses in the QUEFTS framework, linking soil and/or plant data with nutrient supply. This analysis will allow an appraisal of the potential of plant leaf collection campaigns as an effective, complementary methodology to improve the speed and cost-effectiveness to map nutrient deficiencies at scale and reduce the need for high numbers of costly and time-consuming NOTs. This forms part of a larger exercise planned for 2019 to provide solutions for understanding nutrient response in new geographies in faster and more cost-effective ways, building on the learnings from the ongoing field activities.

**Output 1.4: Cassava growth models developed and used to advance field testing**

In February 2018, a training workshop was held on crop modelling using DSSAT for IITA scientists and PhD fellows as a joint effort of the ACAI and TAMASA (Taking Maize Agronomy to Scale in Africa) projects. As result of this training, the researchers are now able to simulate the performance of cassava and maize under contrasting conditions using DSSAT.

After the DSSAT training, a first attempt was made to calibrate the model for the variety TME419, using the data collected in the research trials in SE Nigeria. Mainly the available biomass partitioning data were used to adjust the coefficients and further revision would be necessary using data on time to branching, leaf production, and leaf size. The coefficients from this calibration exercise were then used to estimate the yield of 39 NOTs in Nigeria, and we found that the model overestimated those yields in most of the locations. This was assumed to be attributed to differences in crop management, and possibly also because the highest fertilizer rates in the NOTs do not yet fulfil cassava's nutritional requirements under optimal management. Before expanding the exercise to obtain additional trial data, the calibration and performance of the DSSAT model was reviewed.

After the release of the cassava model in DSSAT in November 2017, continued effort was invested to improve the model, solving bugs and improving the relationship between leaf area index (LAI) and leaf weight. An updated version of the model is currently being prepared for release. In addition, the UF team has completed a sensitivity and uncertainty analysis of the cassava model which contributes to the evaluation of the interactions of the coefficients and their joint effect in the performance of the model. Such an analysis is recommended before the calibration to identify the most sensitive parameters of the model with largest influence on the outputs. An advanced draft manuscript on this analysis is available and will be submitted in a peer-reviewed journal in early 2019.

The LINTUL model has also been further improved (Ezui et al. 2018). An initial evaluation of the performance of the LINTUL modelling framework using the data from the plots receiving the highest rate of NPK from 39 NOT locations in Nigeria revealed good prediction of the high yields (> 25 t/ha) and an overestimation of the lower yields. The latter was initially attributed to suboptimal management practices like the lack of timely fertilizer application and/or weeding, rather than the model not accurately accounting for drought conditions. Further investigations using trial data from the scheduled planting trials however showed that the model falls short in predicting the impact of dry conditions during the bulking stage, not sufficiently penalizing a cassava crop with a well-developed canopy, and underestimating recovery of a younger cassava crop after rains resume. The discrepancy between observed and modelled yields is largest for late-planted cassava, and therefore less of an issue for the FR use case, as fertilizer application is only recommended when the crop is expected to receive sufficient rain during the first three months after crop growth to permit assimilation of the applied nutrients. For the SP use case however, the need for improved model predictions is critical to allow predicting the impact of changes in planting and harvest date on the final yield. This stresses the need for further calibration and improvement of the model. A working group was established to fast-track the improvements of the models, as this is primordial to enable the DSTs to provide correct recommendations.

**Output 1.5: QUEFTS modelling framework developed and used as a basis for the site-specific fertilizer recommendation tool**

We use the QUEFTS modelling framework to predict the response to additions of N, P, and K. These predictions are based on estimations of the indigenous soil nutrient supply (related to soil properties), and the physiological nutrient use efficiency (PhE) of cassava (conversion of indigenous soil nutrient supply to nutrient uptake, and root yield). For the former, we initially used the equations provided by Howeler (2017), while the latter conversion was calculated based on maximum dilution and accumulation curves within the QUEFTS framework, using the formulas to correct for harvest index (Ezui et al. 2017; Sattari et al. 2014).

In the first half of 2018, we made substantial improvements to the QUEFTS framework. First, we evaluated the ability of the QUEFTS framework to convert nutrient supply into root yield. To this end, the yield data from the treatments with full nutrient addition and the omission of N, P, or K from the NOTs were used. Firstly, a mixed modelling approach was used to distinguish the variation in fertilizer response related to site-specific conditions from the plot-level random noise. This technique is borrowed from breeder statistics, calculating breeding values to relate to genotypic signatures. These so-called Best Linear

Unbiased Predictions (BLUPs) were then used to back-calculate the indigenous supply of N, P, and K of the soil. This was done by searching values in the three-dimensional space of soil N, P, and K supply that minimize the total sum of squares between the BLUPs and predicted root yields for these four treatments. We then predicted the control yield and the yield in the treatment with N, P, and K applied at half the rate of that in the treatment with highest rate of NPK. We found correlations with an $R^2$ exceeding 0.9, signifying that the QUEFTS framework is very apt in predicting root yield, when supplied with the water-limited yield, the indigenous nutrient supply of the soil, and the rate of N, P, and K supplied by the fertilizer.

Secondly, we evaluated the ability of the LINTUL framework, building on the results described under Output 1.4. The comparison between observed yields in the NOTs and LINTUL-modelled yields for the treatments with high rates of NPK applied showed that LINTUL provides estimates that are within 15% accurate for yields of > 25 t/ha. While this is adequate, further improvements will enhance the prediction of NPK response, and therefore merit further effort. This allowed us to identify locations where root yield, and consequently fertilizer response is limited by suboptimal crop management, and which we excluded from the next step in the analysis, as the calculated indigenous nutrient supply are likely underestimated.

In the final step of the analysis, we related the calculated indigenous nutrient supply to all available soil information through the SoilGrids, provided by ISRIC. We applied several machine-learning techniques, including partial least squares, random forest, the least absolute shrinkage and selection operator (lasso), and ridge regression. Results varied and some of the methods were not sufficiently conservative, with best predictions obtained through the latter two techniques. In general, between 10 and 40% of the total variation could be explained, with the highest values for N, and the lowest for K. While not impressive, this still allows important improvements to be made over blanket recommendations.

Various avenues were explored to further improve these predictions. The additional data from the NOTs harvested in the second half of 2018 was integrated into the prediction models, and this only resulted in minor improvements in the model's prediction accuracy. A variance component analysis demonstrates that equal portions of variability in nutrient response is observed at large (> 50 km) and small (< 5 km) scale. A closer investigation into the model predictions showed that the current SoilGrids data is not able to pick up plot-level and management-induced variation in soil fertility. Complementary local soil information is needed. We attempted to build in additional information based on local soil type, crop history, and past soil management indicators but quickly learned that the value of such parameters is very context-dependent. Different parameters contribute in different ways in the geographic regions within the target intervention area in Tanzania and Nigeria. We reasoned that the best local indicator of soil fertility is the farmer's recollection of crop yield in his/her field. Classifying control yields in five categories from very low (< 7.5 t/ha) to very high (> 30 t/ha) and including these yield classes in the random forest model substantially improved the model predictions, with $R^2$ values increasing from 0.3–0.5 to 0.4–0.6. In September 2018, we brought together a team of experts on tailoring fertilizer recommendations from CIMMYT-TAMASA, IPNI, OAF, ISRIC and IITA to discuss this further. The strengths and weaknesses of the method were discussed, including possibilities to test the principles beyond the current ACAI context, and to improve the current soil input data from SoilGrids.

**Output 1.6: Impact of agronomic interventions on the dry matter and starch content of cassava produce determined**

Since the annual review meeting in Mwanza, additional yield and starch content measurements have been carried out, and to date, 3775 starch measurements have been conducted (an additional 2151 measurements since December 2017). After the completion of the harvest of the second season trials in Nigeria, the analysis assessing the impact of agronomy interventions on starch content was updated. The negative impact of imbalanced fertilizer application on starch content was not confirmed. Fertilizer application did not affect root starch content in the NOTs in 2018, or across both 2017 and 2018. Tillage regime did not affect root starch content, as also observed last year. Some minor varietal differences were observed in 2018, contrary to 2017. Most of the variation in starch content however was again attributed to environmental conditions and crop age, together accounting for almost 80% of the observed variation. In Nigeria, this can be adequately predicted by sampling, considering the month of harvest to predict starch content, with a prediction error of 2–7% across the year. The highest starch concentrations of up to 40% are observed during the dry season, versus 15–20% after the onset of the rains. In Tanzania, however, harvest month does not contribute to the prediction of starch content. Clearly, starch content is related to the rainfall conditions prior to harvest. The simple solution described is only applicable in Nigeria, as rainfall conditions are less variable across years in comparison with Tanzania. For Tanzania, a crop or empirical model is needed to relate rainfall conditions to root starch content. Improvements in the prediction models were carried through into the scheduled planting and high starch DST.

**Output 1.7: Impact of improved weed control practices compared with current practice**

This output was introduced in 2017, based on the opportunity to expand learnings and approaches of the Cassava Weed Management Project (CWMP) for weed control in Tanzania. A total of 10 demonstration trials have been set up in the Lake Zone and eastern Coastal Zone of Tanzania, evaluating the acceptability, effectiveness, and profitability of a set of best-bet weed control options designed by the CWMP. These use combinations of manual herbicide-based and mechanical weed control (using modified small mechanical tillers) and/or agronomic practices (tillage and intercropping).

This activity generated interest particularly with the Cassava Seed Entrepreneurs (CSEs) supported by MEDA. In the September season, this activity was expanded: another 18 demonstration trials were established alongside selected seed multiplication fields of progressive CSEs. While identifying the most effective and profitable options, this will also stimulate early experimentation and adoption amongst commercial cassava growers, linked with the CSEs.

As in 2019, ACAI received a supplement to strengthen the development of effective technologies for weed control. These activities will be strengthened, targeting the development of a DST for weed management, and integrating weed management into the best planting practices use case. The current setup in Tanzania provides the first insight into the applicability and feasibility of the "six steps of cassava weed management" under Tanzanian smallholder conditions. In 2019, we will continue to evaluate these principles in multilocational on-farm validation exercises.

## WS2: Developing a geospatial cassava agronomy information base

WS2 contributes to IO 1.2 of the project: *By 2017, geospatial information to reduce the cassava yield gap is integrated in the development of decision support tools for cassava intensification.* WS2 supports the development of the DSTs by compiling and/or generating accurate and up-to-date relevant geospatial information, including crop maps, soil constraint maps, and historical and near-real-time weather information for two purposes: (i) to design sampling frames and guide site selection in order to maximize representativeness, and (ii) to enable extrapolation of trial and survey findings across the target intervention areas (use case-specific) with maximal predictive accuracy. In 2018, we continued to expand the compilation of GIS layers, started the development of recommendation domains for the various use case tools, and concluded the yield assessments as the final part of the baseline exercise. WS2 also hosts the development and maintenance of all data collection and management tools and software, which we continue to improve.

### Output 2.1: Tools for deciding on sampling frames and extrapolation developed

The strategy for laying out trials and deciding on sample size was developed in 2016 and detailed in previous reports. We continued to apply this technique for laying out trials, as well as for the validation exercises (see WS3).

After the last ongoing researcher-managed on-farm trials have been harvested and all soil analysis results are available, this strategy will be scrutinized and improved, to allow adjusting sampling frames to account for a higher/lower influence of environmental conditions on technology performance than currently expected. This analysis is part of an exercise to define a "turnkey" solution to conduct "agronomy at scale", enabling optimized investments in field activities while minimizing prediction error, when adapting the recommendations to new areas beyond the current target intervention areas.

### Output 2.2: Recommendation domains for the deployment of specific tools and applications developed

The baseline household survey started in Nigeria and Tanzania in 2017 and builds on the rapid characterization survey carried out in 2016. The baseline survey covers all relevant aspects of cassava cultivation, yield, and revenue to assess the impact of improved agronomic interventions introduced through the various use case tools at the end of the project. Data collection on household characteristics and cassava field cultivation has been completed in Nigeria and is almost complete (> 90%) in Tanzania. In Nigeria, a total of 2038 (42% female respondents) households were surveyed in nine states, versus 1260 households (33% female respondents) from 11 districts in Tanzania. Key areas such as general information and composition of sampled households, household assets, agronomic practices, and costs associated with these practices were covered. These data were collected before the validation exercises of the DSTs started to ensure minimal influence on current practices. The insights in cultivation practices were also key in designing the validation exercises, allowing to standardize the evaluation of the DSTs against current practice. Data quality checks and detailed data analysis are ongoing.

Yield data started in May 2018 and aims to cover the full harvesting window in each of the regions. This is now complete in 1458/2012 and 766/1214 in Nigeria and Tanzania, respectively. We are relying mostly on extension agents as enumerators for the yield assessment exercise, and trained them in the data collection procedures, processes, and method. This will enable learning and future integration into partner processes. The procedure also provides the farmer with immediate feedback on his land area (measured by GPS), his anticipated yield (based on a sample of uprooted plants), and his total crop production and gross value (based on his/her reported unit price). Results showed an average yield of 10–15 t/ha in farmers' fields, but varying between 5 and 50 t/ha, and more than two-fold differences in yield between local varieties and the improved varieties used and promoted within the ACAI project. We also learned that these varieties are cultivated by about 30% of the farmers. Average plot sizes for cassava vary between one and three acres, but only farmers cultivating more than five acres were generally able to correctly indicate the size of their plots. This has important implications for the DSTs, where land area is an important input variable to correctly assess the total cost of the investment.

A second activity under this output involves the delineation of recommendation domains. The code for this was developed in close collaboration with AfSIS (see 2017 report). Geospatial models have been fitted using the yield data from the first season's trials to link the performance of specific agronomic interventions to GIS-based agro-ecological variables (including soil layers developed by AfSIS, Sentinel 2 satellite data, and climate data). This now provides insights into the variables important for tailoring recommendations, and we can assess to what extent we have covered the variation in these specific properties within the target intervention areas of the primary development partners, and beyond. Where the weighting of the individual variables was either uniform or user-defined during the conceptualization (and also for the sampling frames), this can now be informed based on the relative contribution to the prediction of the tailored recommendations for each individual use case. We applied this technique to develop a first draft set of recommendation domains for the individual DSTs. Maps were produced that depict the likelihood that the tool will perform, calculated as the "similarity" (using Mahalanobis distance) with the locations that were used to calibrate the tool. Current versions are still based on a single season's data and thus need to be interpreted with caution. These will be updated and scrutinized using cross-validation in 2019.

**Output 2.3: Geospatial layers to support the use cases (e.g., weather, soils) available**

The current set of GIS layers compiled and used for various activities (including design of sampling frames, geospatial analyses, and the development of recommendation domains) was described in the 2017 annual report.

The quality and resolution of the GIS layers is crucial for the success of applying the principles of agronomy at scale, as it directly dictates the potential accuracy of the site-specific recommendations. In the first half of 2018, the value of the available GIS layers to predict the indigenous nutrient supply was investigated (see Output 1.5), focusing on the parameters available from ISRIC's SoilGrids. The machine-learning algorithms selected the following variables: exchangeable K, Olsen-P, organic matter content, pH, bulk density, CEC, field capacity, wilting point, soil water saturation, clay, sand and silt content in the top 30 cm, capturing up to 40% of the total variation. In 2019, we aim to investigate these relationships further, and attempt to improve these using regionally calibrated soil GIS products, rather than the general Africa SoilGrids layers, and look more closely at aspects of scale and resolution.

**Output 2.4: Database infrastructure for capturing and storing agronomy information operationalized**

In 2018, we continued to streamline procedures for data collection, storage, processing, and reporting. We maintained high levels of efficiency and speed of data collection in the field, and improved processes to standardize data verification and analysis of incoming data. A suite of scripts automatically downloads and processes incoming data, provides visual overviews and data reports, and allows agronomists to have insights in collected data within 24 hours after collection of data in the field. We've also built interfaces to allow all project partners to query and subset the data through a web interface in R Shiny. This is also a critical component of the validation exercises, to streamline the supervision of the validation exercises, whereby close to 2000 participant cassava growers participate in a pilot study testing the tools across the two countries.

We engaged several other agronomy projects to adopt the system, consolidating efforts for further improvement, and started building data exchange procedures with the CassavaBase team, which will host all the data collected by the ACAI project on its OpenAccess platform. To that end, we also collaborate with various organizations on the development of a standardized agronomy ontology and have translated variables to the existing cassava ontology where possible. The "SandMan" system (Smart Agronomy Data Management System), as it was baptized, has received much attention with the CGIAR Research Program on Roots, Tubers and Banana, and the Big Data Platform. All project documentation is now also more consistently being stored on the ACAI SharePoint site, available to all project members, and in line with lead institute's (IITA) new policy.

## WS3: Production and validation of demand-driven support tools for cassava agronomy

WS3 contributes to IO 1.3 of the project: *By 2018, cassava agronomy decision support tools are used by primary partners with target smallholder farmers.* Under WS3, cassava agronomy DSTs are developed based on specific requirements (use cases) from partners with active dissemination networks engaged in the cassava value chain. These tools will be adapted to the skill sets of extension agents and the context within which they operate. Six operative first versions (V1) of the DSTs had been developed and demonstrated to the primary development partners during the annual review meeting in December 2017 in Mwanza. In 2018, these tools were further improved and packaged as ODK forms to ready the tools for field use and facilitate the implementation of validation exercises. At the annual review meeting in December 2018 in Abeokuta, the second version of the tools were presented, based on at least one season of field data and a cross-validation process to assess whether these tools effectively provide recommendations that outperform current practice for 75% of the users. These tools are currently in the field for further validation in a pilot study. These validation exercises will provide a first "real-life" test of the tools, evaluating the effectiveness under the prevailing conditions in farmers' fields.

In the second half of 2018, we also initiated a process to evaluate what would be the most suitable format for the tools. This involved sessions with extension agents and farmers demonstrating various formats, including paper-based tools (maps, lookup tables, and decision tree guides), USSD (unstructured supplementary service data), IVR (interactive voice response), and a smartphone app). In addition, surveys were conducted to evaluate how the user experience ("look and feel") of the tools can be optimized, and how the end user can be safeguarded against providing unrealistic input data. The latter focused on land area, current yields and input/output prices in particular, as these variables are often the most difficult for farmers to input correctly and have a large impact on the recommendations provided. As we went through this process, we learned that there is no strong preference by any of the actors (development partners, extension agents, or farmers) for any format over the other. Rather, the formats all have specific advantages and disadvantages and can be strongly complementary in reaching different types of end users and/or beneficiaries. Also, we learned that we needed to move faster than anticipated in integrating the various use cases into comprehensive tools that cover all aspects of cassava agronomy. As the engagement of the primary partners intensified, the demand broadened to other use cases than the originally requested ones.

Based on these learnings, we initiated a process to fast-track the development of the next version of the tools to allow starting activities to scale the use of the tools within partner networks (work stream 4) in April 2019, the start of the next growing season in Nigeria. We decided to prioritize the development of the smartphone app and paper-based tools. These tools will be used foremost by extension agents. Later on in the year, the development of USSD and IVR systems will follow, targeting direct use by farmers. For each of the use cases, priority issues to address were identified, and a roadmap worked out to integrate the tools into a single application by April 2019.

**Output 3.1: Use cases identified based on specific demands from primary development partners engaged in cassava value chain activities in the target countries**

This milestone was achieved in 2015 and resulted in the selection of the primary development partners and the identification of the use cases and target intervention areas in Tanzania and Nigeria (see ACAI 2016 annual report).

**Output 3.2: A cassava fertilizer blending decision support tool for the fertilizer blending industry developed and validated (in Nigeria and Tanzania)**

The first version of a fertilizer blending tool has been developed as a web-based openly available software application using R-Shiny. It was presented to Notore and Minjingu fertilizer producing companies from Nigeria and Tanzania, respectively. The underlying modelling framework is identical to that of the site-specific fertilizer recommendation tool, and is described in the 2017 Annual Report. The tool provides an intuitive way to visualize how nutrient requirements vary spatially, and to determine the areas requiring a minimal nutrient supplement, providing ACAI's partners with insights on best nutrient ratios for cassava-specific fertilizer formulations and the potential marketable fertilizer quantities.

After continued discussions with Notore and Minjingu, it became clear that the tool needs to go a step further and propose best-suited ratios of N, P, and K for a selected target area, based on nutrient calculated requirements, either as a single formulation or a combination of a basal and 1–2 topdress formulations. In addition, the tool should also allow calculating the competitive advantage of this blend at a proposed price against common existing fertilizers and their prices in the target area. These functionality requirements will be implemented in the first half of 2019. At the same time, the improved calibrations between the indigenous nutrient supply and soil properties will be implemented to ensure that the tool provides the most up-to-date predictions of nutrient response.

**Output 3.3: A cassava fertilizer site-specific recommendation decision support tool for extension agents developed and validated (in Nigeria and Tanzania)**

After the presentation of the V1 version of the DST, presented during the Annual Review Meeting in Mwanza, a number of improvements were made to the tool. These included simple improvements to the language and format of the tool, as well as improvements to the modelling framework: the second version (V2) of the tool now incorporates the updated estimations of soil nutrient supply described under Output 1.5 and has undergone a first cross-validation. The tool remained packaged as an ODK form to facilitate the implementation of validation exercises. In addition, it was packaged as a smartphone app available on Google Playstore.

These validation exercises are principally side-by-side comparisons of the recommended fertilizer rate against a control, laid out as two small plots delineated within a farmer's field under the farmer's management practice, and can be considered as a first real-life test of the tool. A pilot program was initiated for that purpose, whereby a selection of extension agents and cassava growers volunteered to test the tool in their fields. Extension agents were facilitated and equipped with balances, smartphones, and all necessary materials, while cassava growers received the fertilizer free of charge, on the condition that the necessary data was collected. This was done in close collaboration with the primary development partners who took charge of the training and supervision of the extension agents. Training materials were provided, and the implementation is closely monitored. NARS agronomists provide technical backstopping, and monitor the trials to ensure correct implementation, with a focus on correct delineation of the plots, correct application of the fertilizer, and homogeneous soil and management conditions. Currently 513 trials have been established in Nigeria supported by SG2000 and Notore, and 68 in Tanzania, targeting buyers of seed material from Quality Seed Entrepreneurs supported by MEDA. The season started in November in Tanzania, and planting continues in 2019 to reach a target number of 360 trials. An analysis of the input data from the participants in the validation exercises shows that the tool recommends not to apply fertilizer in 25% of cases. Most often, this happens when the suggested planting date was not deemed suitable to obtain a sufficiently high yield to warrant investment in fertilizer. When fertilizer application was recommended, this was predicted to increase yield by on average 7.5 t/ha and net revenue by US$242/ha, both varying substantially between users.

The second version (V2) of the tool has addressed several limitations that were pointed out during the first demonstration to the primary partners: it no longer assumes a harvest at a fixed crop age, and also the default values for maximal investment, prices of roots, and prices of available fertilizers can be changed by the user. The tool now also integrates the five control yield categories, visualized as pictures of average root stocks for each of the categories. The tool still does not consider a measure of risk associated with erratic rainfall or drought. This will be built into the next version of the application. This added flexibility and functionality obliged us to abandon the possibility to calculate recommendations offline. Accessing the necessary GIS information and processing the input data are too computationally intensive to be done within the app. Internet connectivity is essential, and an R server was set up to receive requests from the app and run the algorithms to calculate optimal fertilizer recommendations. Users do not require internet connectivity while in the field. The data can be submitted later on when the user comes online, and the recommendations are then sent by SMS to the user's phone number or sent by email as a one-page printable schematic overview of the recommendations.

The embedded pdf summarizes all findings and progress with the FR and FB DSTs.

FR_FB_DST
2018.pdf

**Output 3.4: A best planting practice decision support tool for extension agents/farmers developed and validated (in Nigeria)**

The Best Planting Practices (PP) use case focuses on the type and intensity of tillage operations to be conducted after land clearing. It covers plowing (twice, once, or nil) and ridging (ridges versus leaving the land flat). During the first year, we also looked at planting density (10,000 versus 12,500 plants/ha) and found that a higher density of 12,500 plants/ha gives higher yields than the 10,000 plants/ha often applied by farmers, independent of the tillage regime. Comparable to the FR use case, improvements were made to the language and format of the DST, and the tool was packaged as an ODK form to facilitate the implementation of validation exercises. A simplified paper-based tool remains in use in parallel as well, especially to facilitate understanding by extension agents and farmers. Since the decision on investment in land preparation is mostly driven by tractor and weeding costs versus the added revenue from the increase in root yield, an ODK form is easier and more practical to use.

An analysis was conducted to confirm the first findings, using the data from the second season trials. Cassava root yields in the second season followed the same trends: yields increased with tillage intensity, mostly by plowing and less by ridging, but this cannot be generalized across all fields. In over one third of the fields, yields remained low at 10–15 t/ha. As also observed in the first year, this is not soil- or weather-related, but rather has to do with the overall management of the crop, and possibly the dominant weed types and weed intensity in the field. The trials included a comparison of the farmer's weed control method against herbicide-based weed control, but no substantial differences were observed between both methods. These findings were used to refine the recommendations. To discriminate between responsive and unresponsive fields to increased tillage, we currently require the user to indicate the expected yield if at least one tillage operation is conducted, using the five yield categories also used in the FR use case, assuming the user indeed has knowledge of the impact of tillage on yield in his/her field. Investment in tillage is only considered if the indicated yield exceeds a threshold of 15 t/ha. The tool then further considers the cost of plowing and ridging operations, relative to the expected gross revenue calculated using user-defined price information.

In April 2018, we also initiated validation exercises, and a third set of multilocational trials, focusing specifically on the interactions with weed type, pressure, and the effect of herbicide-based weed control on the effects of primary and secondary tillage operations. The latter is a first step towards integration of the recommendations on integrated weed control developed by the Cassava Weed Management Project (CWMP), referred to as the "six steps of weed management in cassava-based systems", and will be further intensified in 2019. An approach comparable to that of the FR validation exercises was followed: 137 farmers volunteered to test the DST in their field, comparing their current tillage practices with the recommended and an alternative (less costly) intervention. Extension agents were trained to apply the tools, lay out the plots, and collect the necessary data. The most common tillage regimes under farmer's practice are zero-plow followed by ridging, single plow without ridges, and double-plow without ridges. Under the recommended practice, these changed predominantly to zero-plow without ridges (if cost of tillage was high or cassava prices low), zero-plow followed by ridging (if plowing was more expensive than ridging), or double-plow without ridges (if plowing was less costly than ridging). For about a third of the participants, the tool recommended no change in practice. When a change was recommended, this resulted in net revenue increases of US$50–200/ha, realized either through saving costs (reduced tillage) or increasing cassava root yields (increased tillage).

  

The embedded pdf summarizes all findings and progress with the PP DST.

PP_DST 2018.pdf

**Output 3.5: A cassava intercropping decision support tool for extension agents/farmers developed and validated (in Nigeria and Tanzania)**

*Cassava-maize intercropping in Nigeria.* The IC DST was improved after the Annual Review Meeting, incorporating feedback received, and packaged as an ODK form to facilitate validation exercises. In 2018, these validation exercises were initiated with the primary development partners, testing whether the standard recommendation of a high maize planting density (40 000 maize plants/ha) and the site-specific recommendation of fertilizer application based on farmers' knowledge about their previous non-fertilized maize crop are correct and/or feasible. The primary development partners of the IC use case, SG2000 and Psaltry/2Scale, received a training in March and April 2018 on the implementation and management of this validation exercise. Based on these trainings they held "step-down trainings" with their extension agents, supported by NARS partners. The extension agents were equipped and facilitated to test the tool with volunteer cassava growers, and 143 farmers subscribed to the pilot program. An analysis of the maize yield data showed that increased maize density without fertilizer application mainly results in an increase in small cobs or cobs unfit for sale, and for about 25% of farmers reduced maize cob yields. Hence, the initial recommendation to advise a higher maize density independent from advice on fertilizer use was discarded. A higher maize density is now only recommended in very fertile fields, or in combination with fertilizer use. We found that the tool gave the correct recommendation for 45% of farmers, and for 36% of the farmers incorrectly recommended to not apply fertilizer (false negatives). Only for 4% of farmers, the tool recommended investment in fertilizer, while this did not result in revenue increase (false positives). The tool is currently thus conservative, protecting farmers from incorrect advice. Changes in the decision rules can improve the true positive rate, but not without simultaneously increasing the false positive rate. We will consider bringing in the farmer's risk attitude to provide risk-loving farmers who can afford the investment with less conservative advice than resource-poor and more vulnerable farmers.

We also concluded the harvest of the cassava crop from the 145 multilocational IC trials that were established in 2017. The effects of planting density and fertilizer application on the production of maize were detailed in the 2017 Annual Report. The first year's cassava yields showed no trade-offs between maize and cassava yields at the densities tested. In the second season, we observed a yield penalty of about 1 t/ha on the cassava when intercropped with maize at higher density. The next version of the application will consider this loss in revenue from cassava when making recommendations on increased maize density.

*Cassava-sweet potato intercropping in Tanzania.* We have obtained data on both sweet potato and cassava yields from the second season on-farm and on-station trials, and sweet potato yields for the third season. The third season cassava will be harvested in February 2019. As in the preceding season, sweet potato yields were lower under high density when intercropped with cassava, and delayed planting of sweet potato substantially affected sweet potato yields. Cassava root yields showed similar trends. Delayed planting of the sweet potato probably increases the below- and aboveground competition for resources for both crops. While the competition between the two crops is high (as anticipated), results do show favorable land equivalence ratios (LER), varying between 1.4 and 1.9. Both for sweet potato and cassava, yield penalties of 20–40% were observed relative to the monocrops. While cassava yields are not yet available, the LER will likely be lower than in the first season but remain favorable. This now allows developing a DST following the same principles of the cassava-maize intercropping DST, where decisions on whether to invest in intercropping will primarily be driven by overall profitability based on relative prices for the produce of both crops, and the farmer's relative importance to early income from sweet potato relative to the loss revenue from the reduced cassava yield.

The embedded pdf summarizes all findings and progress with the IC DST.

IC_DST 2018.pdf

**Output 3.6 & 3.7: A scheduled planting and high starch content decision support tool for farmers supplying the processing sector developed and validated**

The Scheduled Planting and High Starch tool covers two ACAI use cases, being a DST enabling EAs and development workers to recommend best timing of planting and harvest to cassava growers supplying roots to processors. Essentially this tool empowers cassava growers to make decisions on their planting and harvest date to maximize their gross revenue based on expected variation in prices or prices by starch content exhibited by the cassava processors. The tool was modified to facilitate the implementation of validation exercises with CAVA-II and Psaltry/2Scale in Nigeria, and CAVA-II in Tanzania. In total, 194 farmers are currently participating in Nigeria, and 154 in Tanzania. As this covers cassava production across the entire years, additional participants will sign up in 2019. Participatory rural appraisal exercises are conducted to identify participants with cassava fields meeting specific criteria and covering the entire planting window in each region. Each participant will harvest a section of his/her field at the intended harvest date, and another at the date recommended by the DST, and compare gross revenue. As for the other validation exercises, extension agents were trained and facilitated to run the DST, lay out the trials, and collect all the necessary data. Trainings were held with the primary development partners in April, and they then arranged "step-down trainings" with their extension agents in the following months. The major limitations with this tool are that farmers are often too optimistic about prices outside the usual harvesting windows, and/or have difficulties to judge price variation across the period of 8–14 months after planting. This results very often in recommendations advising farmers to either harvest very early, or very late, especially in Tanzania. In Nigeria, most often a delay in harvest is recommended driven by yield accrual.

Apart from these validation exercises, we continue the scheduled planting trials, evaluating growth and yield for various planting dates (4–6 plantings per year) and harvest ages (8–12 months after planting), in three locations in Tanzania and three locations in Nigeria. Data from these trials is used to calibrate, improve, and validate the DSSAT and LINTUL modelling frameworks underlying the SP/HS DST (see Output 1.4) to predict root and starch yield as affected by soil and weather conditions during the growth period. In addition, we also started observational studies within cassava fields planted across the year (especially with Niji and Psaltry) as a means to validate these models, and better predict the impact of planting and harvest date on root and starch yield. The latter is done in the framework of a new PhD project. Data from this work will be integrated in the next version of the DST (V2—validated tool) in the last quarter of 2018. We are also exploring possibilities to use actual rainfall received (for a crop currently in the field), rather than average rainfall (from historical) data, as well as possibilities to present risk and uncertainty associated with the recommendations due to erratic rainfall. If successfully contributing to better advice, these features will be built into the next version of the tool.

The embedded pdf summarizes all findings and progress with the SP and HS DSTs.

SP_HS_DST - 2018.pdf

**Output 3.8: A specific decision support tool and applications developed within the context of cassava value chain initiatives managed by partners in Ghana, Uganda, and DR Congo**

At the end of Year 1, a decision was made to postpone identification of partners and use cases to 2019, and start activities in 2020, focusing purely on the groundwork, validation, and adaptation of the existing tools. A decision was reached in the Project Advisory Committee meeting during the annual review meeting in December 2019 to not initiate any project activities in the tier two countries. Rather, it was suggested to focus efforts in Nigeria and Tanzania and formulate learnings on how the development of new tools or expanding the geographic relevance of the existing tools to new geographies can be done most effectively and develop the methodology and approaches as a "turnkey" solution to "agronomy at scale".

## WS4: Facilitation of the use of decision support tools to primary and other development initiatives

Activities in WS4 focus on facilitating the use of the DSTs within the dissemination networks of primary partners and beyond. Specific attention will be given to the direct engagement of women farmers and EAs. All outputs are related to the dissemination of tools, after these have been validated (i.e., after V2 has been delivered and validation exercises have been carried out under WS3 in 2018). Most WS4 activities will therefore only start in 2019 (Year 4). The activities with primary partners contribute (similarly as WS3 activities) to IO 1.3: *By 2018, cassava agronomy decision support tools are used by primary partners with target smallholder farmers.* In addition, it is also important to create awareness around the tools beyond the primary partners directly engaged in project activities.

Activities in WS4 also contribute to IO 2.1: *By 2019, new partners/initiatives are actively working with the project to adapt the decision support tools to their own needs.* This outcome is primarily covered through the cassava clusters, led by CABI, and through a project supported by RTB Cluster 5.4 on "Scaling Readiness", implemented by Wageningen University, IITA, Bioversity International, CIAT and CIP (see Annual Report 2017).

**Output 4.1: Grass root events organized around decision support tools and applications**

This is an output to be delivered in year 4. These events will be organized around demonstration fields of the partners where the use of the tools will be applied, as well as around the validation exercises, allowing participants to share their experiences and promote the use of the tools with their fellow cassava growers, but also create interest in the tools by various new research and development organizations and local and national government agencies. Where possible, this will be done as validation trials are being harvested, so that visitors can observe the yield differences between current and recommended practice.

**Output 4.2: Farmer-friendly training videos and fact sheets developed and tested for efficiency**

This is an output to be delivered in year 4. We have started preparations for this, and have engaged with the team of AccessAgriculture, who produce farmer-friendly videos and publish these in local languages. In Tanzania, a first video was produced focusing on the importance of quality seed and good agronomic practices, targeting the buyers from MEDA's Quality Seed Entrepreneurs. This is very important in Tanzania given that all use cases depend on this, and particularly the use of improved varieties that resist cassava brown streak disease (CBSD). In Nigeria, a video focused on the methodology developed for rapid assessment of cassava root yield to quantify total crop value to aid farmers in decision making on harvest time. These videos will be made available on the website of AccessAgriculture in early 2019.

Furthermore, a new MSc student performed a study to identify cassava grower typologies and relate this to willingness and capacity to try out the recommendations provided by the DSTs. She conducted a series of choice experiments in September–December 2019 with a selection of farmers who participated in the baseline survey. She included an evaluation on whether exposure to video material on the FR and SP use cases, and testimonies by participants in the validation exercises positively influence the interest of farmers in the tools. Data will be analyzed early 2019

**Output 4.3: Capacity of extension agents and last-mile delivery partners developed to use the decision support tools and applications and convey relevant information to farming households**

In 2018, validation exercises are being implemented to test the first versions of the DSTs for each use case. These exercises are led by the primary partners of ACAI who involve their extension agents in managing validation trials jointly with their farming clientele. To enable the primary partners, a training-of-trainers event was held for each use case in Nigeria, and the same is planned in July and August 2018 in Tanzania. Partners then organize "step-down trainings" with the support of the NARS partners. These trainings include the relevant theoretical background for each use case, hands-on exercises in laying out plots according to requirements of the validation exercise, and hands-on exercises on the use of ODK and smartphones to obtain site-specific recommendations, along with instructions for testing their validity, data collection, and trial monitoring. All participants in the pilot study are required to register and receive an ACAI ID card and all tools and equipment necessary to carry out the exercise. A total of 111 extension agents have been trained in Nigeria, while in Tanzania currently 57 extension agents have been trained, while training continues early 2019. Adding to this the EAs engaged and registered in other project activities; we currently have engaged a total of 758 extension agents across all partners in the two countries. By use case, this amounts up to about 50% of the target EAs for the FR, PP, and HS use cases, and close or beyond 100% for the IC and SP use cases, based on the ex-ante analysis to achieve the target number of farmers impacted. The extension agents currently involved are predominantly male (85% in Nigeria and 68% in Tanzania). Aspects of gender will be carefully considered in the training events to ensure that the capacity of female extension agents is equally built, and both male and female farmers learn about improved practices and can equally access the DSTs when taking the DSTs to scale.

In addition, we aim to develop a training package, which will be posted online and permit the primary development partners as well as interested secondary partners to independently carry out additional validation exercises. The tools provide all technical information for coordinators and lead agronomists, as well as practical guides for extension agents, and simple flyers for participant cassava growers. Furthermore, the training package contains all necessary information to register and access the DSTs and data collection tools, as well as access to the platform to download and process the data collected.

**Output 4.4: Awareness of ACAI DSTs created and applications implemented in the target countries beyond the primary partners and their target areas**

This is an output to be delivered in year 4. We are currently focusing on the development of communication materials for use in awareness campaigns, and have started engaging with local media, especially radio. The use of the DSTs will be widely promoted once validated versions are available for independent use by interested actors in the cassava value chain.

In August, ACAI participated in the Nane Nane agricultural fair in the various zones of Tanzania, together with MEDA. We highlighted the potential of agricultural intensification of cassava and showcased the DSTs to the visitors at the fair. In November, ACAI, in collaboration with the NRCRI and FUNAAB, hosted a demonstration stall at the AGRA Innovate West Africa conference in Lagos. These activities generated interest in project activities from a wide variety of potential partners in both countries. These include large-scale cassava growers, industrial processors, dissemination service providers, and other international organizations which are keen on tapping from the technology developed by ACAI. Further, ACAI has proactively sought partnership with tech companies that can provide platforms for hosting and disseminating ACAI tools. We have held discussions with eSOKO in Tanzania, Arifu in Kenya, and Viamo in Nigeria to come up with a package suitable to sustainably serve ACAI target beneficiaries.

**Output 4.5: Cassava clusters established with engagement of all major stakeholders operating within cassava value chains in the target countries**

A meeting was held between CABI and IITA in March 2018, to discuss the next steps for effective engagement of clusters in addition to the two cluster meetings held in Abuja and Zanzibar in 2016 and 2017, respectively. The meeting agreed that part of the cluster engagement is to strengthen the alignment of the project research outputs with partners' needs in addition to expanding the base of partners beyond the ACAI primary partnership. It was however noted that it may not add immediate value to convene yet another cluster meeting in 2018 when the DSTs have not been fully validated. This therefore called for a different approach for catalyzing information flow among clusters. CABI has been supporting the ACAI project with advice on the tool development, based on their experiences in the OFRA project. In early 2019, ACAI will engage CABI in the development of tools and manuals to support the trainings on DST use by extension agents, as well as promotion materials to be used at the various promotion events.

Further, CABI completed the literature survey in June 2018. The output from the survey entitled *Cassava value chain analysis in Nigeria: An information perspective*' was also shared at the 4th Scientific Conference of the Global Cassava Partnership for the 21st Century – GCP21-IV, 11–15 June 2018, in Cotonou, Benin. The conference was convened by IITA and partner agencies. The survey aimed to highlight key information gaps and opportunities for contributing to strengthening the cassava value chain. It specifically sought to establish information needed, sources of information, and how it is accessed and used by the different value chain actors to enhance operational efficiency and improve gains at all links of the cassava value chain.

## WS5: Capacity development of national institutions to engage in transformative cassava agronomy R4D

WS5 aims at institutionalizing new approaches for cassava agronomy within the national research systems and will be led by the project management team with direct engagement of the NARS scientists and other research partners. The aim of WS5 activities is to strengthen the capacity of NARS scientists to participate in and independently conduct transformative agronomic research, and to enable these scientists to apply and integrate principles of agronomy at scale within their own initiatives and projects other than ACAI. These capacities focus on agronomy know-how, and on aspects of data management, GIS and geospatial statistics, crop modelling, and laboratory capacity for soil and plant analyses. WS5 contributes to IO 3.1 of the project: *By 2019 at least five scientists per national system have been leading the implementation of activities within the context of this initiative*. Implementation of research activities in both Nigeria and Tanzania is led by NARS partners. The team of NARS researchers involved in the coordination of the ACAI has been further expanded to 17 members in 2018, especially bringing in more socioeconomic expertise to support the survey activities and the validation exercises.

As part of the capacity building efforts, ACAI supports a total of seven PhD projects and 13 MSc projects, fully integrated within the development of the use case tools. Two of the MSc students graduated in 2018. All student projects are on schedule to graduate before the end of the project in 2020.

**Output 5.1: Capacity of research institutions to conduct effective Cassava agronomy research enhanced**

In 2017, a total of 139 persons (75 in Nigeria, 64 in Tanzania) with 32% female participation were trained in various aspects of agronomy research. In January 2018, the project management team met and discussed further training needs on agronomy research. A plan was developed to advance knowledge by focusing more on self-supported use of the skills acquired within the NARS partner institutes. Each of the partners identified candidates who will become deeper involved and learn to apply these techniques independently and on-the-job. They identified working examples beyond the activities of the ACAI project and were mentored by ACAI researchers. In addition, a refresher course on data collection techniques and barcode labelling was provided in the third quarter of 2018, and back-to-back, a new course on statistical data analysis using R, digital data collection using ODK/ONA, and principles of GIS to guide sampling frames using ArcGIS and R in both countries. These trainings were attended by a total of 52 participants (25 in Nigeria and 27 in Tanzania) with 25% female participation. Starting in 2019, we will provide monthly follow-up virtual trainings on specific topics to sustain continued learning and application of the principles to topics and questions from the NARS partners in other initiatives than ACAI.

**Output 5.2 Institutions capacity to develop and manage standardized databases enhanced**

In 2018, a decision was taken in the January PMT meeting to focus training on strengthening the capacity of NARS partners to perform digital data collection in the field, independent from the ACAI project. This will cover the use of ODK and barcoding, designing xlsform and establishing a cloud-based platform to aggregate submissions from enumerators in the field. For interested participants, the training will also continue to cover various aspects of statistical data analysis and reporting of results. To that end, a four-day training session was organized in the September 2018 in Abeokuta, Nigeria, and in October in Mwanza, Tanzania. This training focused on working examples identified by participants from within the NARS partner institutes. After the initial training, working groups were established within each of the NARS stations to permit trainees to discuss progress, obtain feedback, and receive support from ACAI researchers through monthly virtual training events.

**Output 5.3 Skills in geospatial data analysis among institutions enhanced in coordination with AfSIS**

This training was originally planned in 2017 but postponed to 2018 to allow a more focused approach, training selected NARS scientists with basic skills in GIS and statistics. A total of 25 (15 male, 10 female) candidates with some background in GIS were identified for this training and were trained in separate sessions by IITA GIS specialists. The training was very much hands-on and focused on working examples identified by the participants. Topics handled included (i) accessing open data and GIS layers, (ii) common GIS techniques and data processing, and (iii) generating maps for various purposes, including sampling frames and reporting results. The use of Opensource software was encouraged.

**Output 5.4: Strengthened capacity of national research institutions and primary development partner organizations in project management**

A training was organized in both countries in 2016 (see annual report 2016). Further capacity building is done through on-the-job training, through regular interaction between IITA project management staff and key staff in the respective national research institutes, focusing on key aspects of project implementation, leadership, and financial management to ensure timely, transparent, and accurate reporting following to agreed guidelines. A follow-up in-person training was provided to the TARI zonal accountants by the IITA finance manager of the ACAI project in Dar es Salaam in September 2018. A similar training is planned with the NRCRI and FUNAAB accountants in early 2019.

**Output 5.5: Standardized soil and plant analytical laboratories network including standard operating procedures to support cassava agronomy established**

Training sessions were organized in 2017 (see 2017 Annual Report), but we continue to provide support through on-the-job training, particularly for the sample labelling, processing, and handling.

## WS6: Project governance, management, coordination, and ME&L

WS6 will ensure that (i) the project is planned well, (ii) technical and financial reports are delivered in time, (iii) appropriate monitoring, evaluation and learning (ME&L) and communication channels are put in place, and (iv) governance and decision-making processes are functional. A multilocational, multi-partner, gender-inclusive initiative like ACAI requires proper reporting and ME&L tools to ensure consistency of project implementation and reporting as well as cross-learning between target countries. Various tools and strategies have been put in place to ensure smooth operations.

**Output 6.1: Project staff and capital equipment available**

Following approval by the PAC during the December 2017 planning meeting, the new organogram was adopted in January 2018. All capital equipment was purchased in 2016. As ACAI has received a supplement and will integrate activities to research, develop, and scale effective weed management technologies as a continuation of the Cassava Weed Management Project, this organogram will be revised in January 2019 during the project's strategic meeting to include new roles and responsibilities of the additional team members.

**Output 6.2: A technical and financial reporting framework available**

This has been in place since 2016. Partners are required to report on progress half-yearly. The country teams also have adopted a monthly progress review session which enables the team to evaluate status progress against budget and identify areas that need realignment in good time. The NARS partners are involved in this process.

**Output 6.3: A gender-inclusive ME&L framework operationalized**

The ME&L plan has been finalized and was operationalized through the use of an agreed data matrix for data capture and reporting at project level shortly after project initiation. In 2018, partner ME&L focal persons in Nigeria and Tanzania were taken through the ACAI ME&L plan to ensure common understanding of the framework, integration of ME&L processes into their structures, data requirements, and roles and responsibilities. In addition, we also more consistently worked with the development partners to quantify participation in events and exposure to ACAI technologies. All this information (e.g., training details) is captured on the ME&L platform as a part of the ONA data infrastructure. The gender dimension of all required data is given attention to ensure proper targeting of all interventions.

Processes to obtain real-time feedback on the tools were developed (e.g., processes to quantify farmers reached, to assess insights and knowledge gained, and the use of the tools by extension agents and farmers). These processes will be embedded in partner ME&L systems in 2019 for smooth implementation. We continued to improve the existing tools and are more consistently registering the participation of households and extension agents participating in the project. Participants in pilot exercises, surveys, and training events receive ID cards and will be used as a panel to obtain feedback. We will continue to use such participants and a proportion of others to be reached in subsequent years to evaluate changes in practices and uptake of the recommendations.

We also continue to build the linkages between the data resources and quantifying progress against target milestones, to allow close to real-time monitoring of progress. More effort will be invested in this as we start scaling up the utilization of the DSTs in 2019.

**Output 6.4: Yearly and seasonal planning and Scientific Advisory Committee meetings held**

A strategic planning meeting was held in Nairobi in January 2018 for the team to review overall plans for 2018. The project has held monthly PMT meetings from February 2018. Notes and meeting slides are uploaded on the project's SharePoint site. Country level planning meetings were held in Nigeria (February 2018) and Tanzania (June 2018). In addition, several in-country local meetings, usually around specific activities or field monitoring missions, have been held.

The project team continues to use the ASANA project management software to facilitate coordination and communication. The tool has enhanced collaboration among team members.

**Output 6.5: An effective communication strategy fast-tracking the awareness and use of the decision support tools**

For a seamlessly coordinated knowledge exchange and information dissemination, focal persons from the partners and the NARS have been identified, trained, and equipped with cameras and materials to champion ACAI at the grassroot level and help document the project implementation activities.

Pertaining to the support for the development of user interface for the DSTs to test various formats with a panel of end users, we developed the initial design for paper-based tools (table and maps). A specialist consultant was hired to develop a user interface for an android application and short code sms formats. Dummy versions of both formats have been tested by the ACAI team and partners in Nigeria and were presented at the ACAI 2018 annual review meeting in Abeokuta, Nigeria. The aim of this exercise was to evaluate the acceptability and preference for the various formats, as well as gauge the ability to provide the necessary inputs and interpret the outputs and recommendations provided by the tool. The "look and feel" or user experience is expected to have an important impact on the initial interest to apply the tools, and the early adoption of the recommendations. Accurate and sufficiently precise entry of the required inputs will affect the validity of the recommendations, hence the need for tailoring the tools to the preferences and capacities of the target users.

ACAI participated in the 4th Scientific Conference of the Global Cassava Partnership for the 21st Century—GCP21-IV, 11–15 June 2018, in Cotonou, Benin and made presentations on the scientific outputs as well as organized a workshop showcasing the current versions of the DSTs. This created significant interest in the project with a spike on web visits and feedback online. Weekly updates of project activities via online media have increased the project reach and grown a regular audience per week expanding from less than a hundred earlier this year to more than one thousand weekly hits in June.

Regular ACAI updates can be accessed on the website (www.acai-project.org) as well as on the social media pages:

| | |
|---|---|
| Facebook: | https://www.facebook.com/ACAIproject/ |
| Twitter: | https://twitter.com/ACAI_IITA |
| LinkedIn: | https://www.linkedin.com/company/acai-project/ |
| Flickr: | https://www.flickr.com/photos/153971246@N08 |

For media and visibility, several ACAI members were interviewed for TV news in both countries. We held a media awareness event in Tanzania featuring a guest appearance by the Dr Geoffrey Mkamilo, Director General, Tanzania Agricultural Research Institute (TARI). News articles and opinion pieces were published in five media houses as well as prime time TV news on two channels.

  

## References


Ezui, K.S. 2017. Understanding the productivity of cassava in West Africa. Wageningen University, 34. Retrieved from http://edepot.wur.nl/400833

Ezui, K.S., P.A.  Leffelaar, A.C.Franke, A. Mando,. and K.E. Giller. 2018. Simulating drought impact and mitigation in cassava using the LINTUL model. Field Crops Research 219: 256–272.

Howeler, R. 2017. Nutrient sources and their application in cassava cultivation. Chapter 15: in Achieving sustainable cultivation of cassava (vol 1), Cultivation Techniques, edited by ‘G. Hershey. Burleigh Dodds Science Publishing, UK. 424 p.

Sattari, S., M.K. Ittersum, A. Bouwman, A.L. Smit, and B. Janssen. 2014. Crop yield response to soil fertility and N, P, K inputs in different environments: Testing and improving the QUEFTS model. Field Crops Research 157: 35–46.


## 2. Project Adjustments

**For each outcome or output that is behind schedule or under target, explain what adjustments you are making to get back on track.**

***Outcome 1*** *(By 2020, a at least 120,000 cassava farmers are benefiting from a total value created of at least 28 million USD through higher cassava yields, higher yields of crops associated with cassava, higher starch content of the cassava, a more continuous supply of roots, and/or the use of appropriate cassava fertilizer, within the target areas of the primary partners in Nigeria and Tanzania) 2019 target*: **At least 10,000 cassava farmers are benefiting from a total value created of at least 3 million USD**.

As scaling activities are scheduled to start in 2019, the project currently cannot assume any value generation. This is dependent on the finalization of the DSTs in April 2019. We have currently registered 2246 farmers who have been directly involved in testing the technologies developed. These farmers may have started adopting the practices and learnings based on their experience gained but this has currently not been quantified. Further, 758 extension agents have been involved across use cases, through which the DSTs will be applied to reach farmers. These 758 extension agents represent 60% of the target number of EAs to train and reach the 120,000 farmers envisaged to benefit from the project. A plan has been put in place at the time of writing this report to (1) finalize the paper-based and app versions of the DSTs by April 2019, as all scaling activities depend on the availability of these DSTs, (2) train 2/3 of the target number of EAs in 2019 in the use of these tools, and aim to reach at least 60,000 farming households through the various training, promotion and dissemination events in 2019, in order to reach the target number of 40,000 farmers benefiting by the end of 2019, and 120,000 by the end of 2020.

***Output 1.1.3*** *(Nutrient norms established, nutrient constraints assessed in the target regions, and this knowledge fed into the activities of outputs 2, 4 and 5) 2019 target*: **1 validated set of nutrient norms available for supporting the development of applications**.

The draft set of nutrient norms developed last year was further improved with newly available data, but full validation is pending on the completion of plant leaf nutrient analysis. These lab results are expected early 2019, after which the nutrient norms will be validated through cross-validation procedures and relationships with yield response to nutrient addition evaluated. This will be completed by July 2019.

***Output 1.3.12*** *(Feasibility assessed and training conducted for a service provision system on herbicide-based and mechanical weed control) 2019 target*: **Ex ante study report available on viability of a weeding service provision system in Tanzania**.

All necessary data for this study was collected by integrating this into the baseline survey, conducted in each of the 4 zones of Tanzania (Lake zone, eastern Coastal zone, southern Coastal zone and Zanzibar). Data is currently being analyzed and will be reported early 2019. This will be aligned and ramped up in 2019, as this will form the basis of the integrated weed management activities and development of a weed control DST for farming conditions in Tanzania, through the supplement received. This will build on the experiences in Nigeria, but modified based on the learnings from ongoing demonstration trials in Tanzania, and complemented with additional field testing.

***Output 1.3.8*** *(Specific decision support tools and applications developed within the context of cassava value chain initiatives, managed by partners in Ghana, Uganda, (and DR Congo)) 2019 target*: **Stakeholder meeting held with at least two development partners in Ghana, Uganda (and DR Congo) and new/adjusted use cases identified**.

This output was not delivered. At the end of Year 1, a decision was made to postpone identification of partners and use cases to 2019, and start activities in 2020, focusing purely on the groundwork, validation, and adaptation of the existing tools. A decision was reached in the Project Advisory Committee meeting during the annual review meeting in December 2019 to not initiate any project activities in the tier two countries. Rather, it was suggested to focus efforts in Nigeria and Tanzania and formulate learnings on how the development of new tools, or expanding the geographic relevance of the existing tools to new geographies can be done most effectively, and develop the methodology and approaches as a “turnkey” solution to “agronomy at scale”. We therefore propose to modify this output, and rather than initiating activities in new countries, develop a framework that details all learnings of the project and formulates recommendations on how the expansion of the current use cases to new geographies can be done most effectively.

Related to this, we have also learned that the partners who originally formulated their demands for the 6 specific use cases, have now expressed interest in broadening their activities to several or all use cases. It became evident that the different aspects of cassava agronomy need to be integrated into a single DST, or a general “cassava crop manager” application. We therefore will invest efforts to combine the various use cases and promote multiple use cases through these integrated DSTs with the primary partners in Tanzania and Nigeria, and make these integrated recommendations available in different formats, rather than a single preferred format per use case.

## 3. Geographic Areas to Be Served

**Provide the most updated list of countries and sub-regions/states that have benefitted or will benefit from this work and associated dollar amounts. If areas to be served include the United States, indicate city and state. Reflect both spent and unspent funds.** Add more rows as needed. More information about Geographic Areas to Be Served can be found here**.**

| Location | Foundation Funding (U.S.$) |
|---|---|
| Nigeria | $8,795,809.50 |
| Tanzania | $7,598,647.50 |

## 4. Geographic Location of Work

**Provide the most updated list of countries and sub-regions/states where this work has been or will be performed and associated dollar amounts. If location of work includes the United States, indicate city and state. Reflect both spent and unspent funds.** Add more rows as needed. More information about Geographic Location of Work can be found here.

| Location | Foundation Funding (U.S.$) |
|---|---|
| Nigeria | $7,530,220 |
| Tanzania | $6,505,312 |
| Kenya | $1,434,914 |
| Belgium | $214,757 |
| Switzerland | $289,734 |
| US (Florida) | $255,000 |
| Colombia CIAT | $164,520 |

## 5. Feedback for the Foundation

**Provide one to three ways the foundation has successfully enabled your work so far. Provide one to three ways the foundation can improve.**

In 2018, we continued to have close interaction with the Program Officer (Christian Witt), and this is very much appreciated. It allows us to discuss progress and highlighting key challenges, and to focus the implementation of activities to achieve the project’s objectives and outcomes. Particularly his support on the strategic thinking towards the “agronomy at scale” concept has been tremendously helpful. Finally, we have also been linked up with experts or other projects / grants, for example with Acumen / Lean data.

In 2019, we would request further support on strategic issues, particularly towards the interaction with agricultural tech sector. As became clear during the annual review meeting, the implementation and successful scaling of the DSTs is a substantial challenge. It requires bringing in the expertise of digital extension companies which are experienced in effectively bringing agricultural advice across to smallholders. We have initiated such interactions and would request to periodically review progress with the program officer. This is a critical aspect to operationalize the “agronomy at scale” concept, with important learnings to be extracted on how tailored advice can be maximally effective at farmer level.

## 6. Global Access and Intellectual Property

**If your funding agreement is subject to Intellectual Property Reporting, please click the following link to complete an Intellectual Property (IP) Report.**

**If not, please acknowledge by typing "N/A": ______**

**To delegate permissions to another member of your project team or for any questions regarding the Intellectual Property Report, please contact GlobalAccess@gatesfoundation.org.**

## 7. Regulated Activities

**Do you represent that all Regulated Activities[1] related to your project are in compliance with all applicable safety, regulatory, ethical and legal requirements? Please mark with an "X":**

**__X___ N/A (no Regulated Activities in project)**

**______ Yes**

**______ No (if no, please explain below)**

| |
|---|
| N/A |

**Are any new Regulated Activities[1] planned which were not described in any documents previously submitted to the foundation? Please mark with an "X":**

**__X___ No**

**______ Yes (if yes, please explain below)**

| |
|---|
| N/A |

1 Regulated Activities include but are not limited to: clinical trials; research involving human subjects; provision of diagnostic, prophylactic, medical or health services; experimental medicine; the use of human tissue, animals, radioactive isotopes, pathogenic organisms, genetically modified organisms, recombinant nucleic acids, Select Agents or Toxins (www.selectagents.gov), Dual Use technology (http://export.gov/regulation/eg_main_018229.asp), or any substance, organism, or material that is toxic or hazardous; as well as the approvals, records, data, specimens, and materials related to any of the forgoing.

## 8. Subgrants

**If your grant agreement (not applicable to contracts) is subject to expenditure responsibility and permits you to make subgrants to organizations that are not U.S. public charities or government agencies/instrumentalities, please complete the Subgrantee Checklist and attach a copy with this progress narrative for each such subgrantee.**

# Financial Update

*The purpose of the Financial Update section is to supplement the information provided in the "Financial Summary & Reporting" sheet in the foundation budget template, which reports actual expenditures and projections for the remaining periods of the grant. This section is a tool to help foundation staff fully understand the financial expenditures across the life of the project. Together, the Financial Update section and budget template ("Financial Summary & Reporting" sheet) should provide a complete quantitative and qualitative explanation of variances to approved budget.*

*Note: If you are using an older version of the budget template, this information could be in a different location in your template.*

## 1. Summary

**Briefly describe how total project spending to date compares against the budget and how your assumptions may have changed as the project progressed.**

| |
|---|
| Overall budget spending was very close to the provision made for the year (2018). Total expenditure was US$ 2,939, 737 with an under-expenditure of US$ 2,037 (less than 1%) against the amount (US$ 2,941,774) provided. |

## 2. Latest Period Variance

**Provide explanation for any cost category variances outside the allowable range. Explain causes, consequences for the project, and mitigation plans if relevant. Report whether or not approval for the variance has been obtained from your Program Officer.**

Note: "Latest period variance" compares actuals to previous projections for the period. See "Financial Summary & Reporting" sheet in the foundation budget template for calculated variance. If you are using an older version of the budget template, this information could be in a different location in your template. Allowable variance is defined in your grant agreement.

We have two cost categories with variances outside the allowable range. These are:

1. **Consultants**: this budget category was underspent. We have an outstanding payment to the consultant supporting the team in developing of the apps. This payment will be cleared in 2019 once all deliverables are met. This has been catered for in the 2019 budget reforecast. We were also able to get consultants at a lower cost than originally budgeted hence some small saving was made.

2. **Travel**: this budget category was slightly underspent. We had some savings mainly from the Annual Review Meeting held in Abeokuta with a reduced number of participants than earlier anticipated.

## 3. Total Grant Variance

**Provide explanation for any cost category variances outside the allowable range. Explain causes, consequences for the project, and mitigation plans if relevant. Report whether or not approval for the variance has been obtained from your Program Officer.**

Note: "Total grant variance" compares actuals plus current projections to the budget. See "Financial Summary & Reporting" sheet in the foundation budget template for calculated variance. If you are using an older version of the budget template, this information could be in a different location in your template. Allowable variance is defined in your grant agreement.

We have one cost category with variance outside the allowable range for the Total Grant amount. This is the consultants budget category. The amount under this budget category has been increased for 2019 due to the following reasons:

1. In 2019, we are gearing towards dissemination and scaling out of the DSTs. To this end we shall be seeking the services of digital solution providers like Esoko, Arifu and Viamo to provide platforms for hosting and disseminating ACAI tools.

2. One of the key activities of the supplement is the alignment of relevant CWMP data to the ACAI database infrastructure towards the development of a Weed Control Decision Support Tool. The data will be made available through the open access data platform (CKAN) and fully annotated to allow cross-project data integration. A consultant who has been handling the CWMP data will perform this task as well as provide biometric support.

3. The social media component was not budgeted for under the supplement as it was initially planned to be outsourced. Part of the work will require backstopping the implementation of the digital component. A consultant will be hired to support this.

## 4. Sub-awards (if applicable)

**Use the chart to provide the name(s) of the sub-grantee(s) or subcontractor(s), actual disbursement for this reporting period, total disbursement to date from the primary grantee to sub-awardee, total spend to date by the sub-awardee and total contracted amount.**

Note: The total of actual disbursements for this reporting period should equal the actual Sub-awards expenses reported on the "Financial Summary & Reporting" sheet in the foundation template for this reporting period. If you are using an older version of the budget template, this information could be in a different location in your template.

| Organization Name | Actual Disbursement for this Reporting Period (U.S.$) | Total Disbursed from Primary Awardee to Sub to Date (U.S.$) | Total Sub-Awardee Spent to Date (U.S.$) | Total Contracted Amount (U.S.$) |
|---|---|---|---|---|
| CIAT | $104,535 | $284,280 | $284,280 | $419,520 |
| IPNI | $173,920 | $481,084 | $481,084 | $816,818 |
| FUNAAB | $81,862 | $285,317 | $285,317 | $285,317 |
| NRCRI | $86,671 | $284,798 | $284,798 | $284,798 |

| | | | | |
|---|---|---|---|---|
| ARI | $215,602 | $626,913 | $626,913 | $626,913 |
| KU Leuven (for PhD) | $26,352 | $101,446 | $ 101,446 | $214,757 |
| ETH (for PhD) | $8,809 | $147,917 | $147,917 | $289,734 |
| MEDA | $15,933 | $15,933 | $15,933 | $15,933 |
| CAVA-II TZ | $11,895 | $11,895 | $11,895 | $11,895 |
| Minjingu Mines & Fertilizer Ltd. | $1,200 | $1,200 | $1,200 | $2,400 |
| FJS | $2,400 | $2,400 | $2,400 | $2,400 |
| NOTORE | $3,000 | $3,000 | $3,000 | $3,000 |
| PSALTRY | $2,997 | $3,000 | $3,000 | $3,000 |
| SG2000 | $15,000 | $15,000 | $15,000 | $15,000 |
| OYSCGA | $7,000 | $7,000 | $7,000 | $9,000 |
| Access Agriculture | $60,000 | $60,000 | $60,000 | $60,000 |

## 5. Other Sources of Support (if applicable)

**List and describe any sources of *in-kind* project support or resources received in the reporting period.**

Note: Names of the other sources of funding and their contributions (U.S.$) should be included in the budget template on the "Financial Summary & Reporting" sheet in the foundation budget template in the Funding Plan table. If you are using an older version of the budget template, this information could be in a different location in your template.

N/A

**Describe how interest earned and/or currency gains were used to support the project.**

N/A

## For Foundation Staff to Complete

**Analysis** (required if contingent payment or PO assessment differs from grantee/vendor assessment)

**Progress Analysis**

*Include analysis of significant project variances and key learnings that may inform portfolio discussions for progress against the strategic goals.*

| |
|---|
| |

**Budget and Financial Analysis**

*Include analysis of unexpended funds or over expenditures. Refer to the Unexpended Grant Funds Policy for options available when recommending how to handle unexpended grant funds, or reach out to your primary contact in GCM.*

| |
|---|
| |

| | |
|---|---|
| **Scheduled Payment Amount** | $ |
| **Carryover Amount** | $ |
| **Recommended Payment Amount** | $ |

**Approver Comments** (if applicable)

| Name | Title | Date Approved |
|---|---|---|
| | | |

**Comments**

| |
|---|
| |