SASHA

PHASE 2-YEAR 4

Annual Technical Report

JULY 2017- JUNE 2018

SASHA

Sweetpotato Action for Security and Health in Africa

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

Investment Title	Renewal 53344 SASHA II: Sweetpotato Action for Security & Health in Africa		
Grantee/Vendor	International Potato Center (CIP)		
Primary Contact	Jan Low	Investment Start Date	June 30, 2014
Feedback Contact1	Jan Low	Investment End Date	July 31, 2019
Feedback Email1	j.low@cgiar.org	Reporting Period Start Date	July 1, 2017
Program Officer	Jim Lorenzen	Reporting Period End Date	30 June 2018
Program Coordinator	Amy Pope	Reporting Due Date	31 July 2018
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Scheduled Payment Amount (If applicable)			

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.

Date Submitted	21 August 2018	Submitted by Contact Name	Jan W. Low
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Progress and Results

1. Progress Details

I. Executive Summary. SASHA Phase 2 (SASHA2) continues to focus on adaptive research to break the remaining bottlenecks to unleash the potential of sweetpotato to reduce undernutrition and food insecurity. Good progress continued to be made in year 4 (Y4) of Phase 2 (see the updated results tracker in Appendix A). Agreed subgrant agreements (SGAs) for Y4 were finalized for 17 subgrantees and 1 new subgrant was signed towards the end of the second half with ETH-Zurich. Of the 32 key milestones, 4 have been completed (12%), 1 is almost achieved (3%), 16 are on track (50%), and 7 (22%) are behind schedule. Most of those behind schedule are due to postharvest storage experiments needing to be repeated and seed system diagnostic tool development taking longer than anticipated. Appendix B provides the detailed expenditures for Y4 (July 2017–June 2018) and spending to date for SASHA2.

Research Program (RP1). Breeding. Population development is conducted at "sweetpotato support platforms" (SSPs) in Uganda, Mozambique, and Ghana, with backstopping from CIP-HQ. Collaboration with 14 national partners ensures efficiency of breeding efforts. Specific breeding objectives are to (1) continue to improve sweetpotato population development in sub-Saharan Africa (SSA), linked with participatory varietal selection at the national level; (2) breed for key biotic constraints in Africa; (3) breed orange-fleshed sweetpotato (OFSP) populations for drought-prone regions in Africa; and (4) breed quality types of sweetpotato for urban markets. A highlight of Y4 is the publishing of a chapter on Sweetpotato Breeding in the Springer book *Genetic Improvement of Tropical Crops.* This year (2017/2018), six countries (Uganda, Burundi, Ghana, Malawi, Madagascar and Ethiopia) released 22 varieties, nine of the varieties were new releases (either bred or selected from seed) and 11 varieties (50%) were orange-fleshed.

To date, significant progress has been made in genetic gains (GG) experiments and improved techniques for collecting and analyzing breeding data. Uganda and Mozambique population programs continued to generate lots of seed for their own use and to share with national agricultural research systems (NARS) partners, with both programs **achieving their numeric targets in seed** shared with partners (targets were 250,000 seed from Uganda; 150,000 seed from Mozambique). Moreover, seed production in Ghana is now moving forward, with the first seed (1,200) shared with partners in 2018 and measures in place to increase seed output in year 5.

Experimental heterosis populations' work continues to be on track. All field work for the Peru-based trials for determining the GG for one complete reciprocal recurrent selection (RRS) cycle using heterosis exploiting breeding schemes (HEBS) was completed in December 2017 for three different targets: Wide adaptation and earliness or WAE; non-sweet sweetpotato or NSSP; and high iron (HIFE) in sweetpotato population improvement. In total, numbers of offspring families in hybrid population H1 were 742 for WAE, 336 for NSSP, and 272 for HIFE. **In all H1 populations, large genetic gains were observed**. For storage root yield, genetic gain estimates ranged from 68.8 to 110.3%. Heterosis increments for storage root yield in hybrid population H1 ranged from 9.3 to 37.6%. All H1 populations exhibit variety ability. Moreover, very large mid-parent mid-offspring heterosis increments for storage root yield were obtained in Uganda for cross of population A & B (UG_A x UG_B), on average 93.2%.

We continue to pursue four approaches to tackling SPVD resistance. So far, 13 DArT markers have been found in association to SPCSV or SPVD. We are in the process to apply these 13 markers available for validation to the parental material in use at Namulonge in combination with the information about SPVD resistance of these clones.

Genetic gain results were a highlight of last year's report. Trials for all breeding objectives in SSA continued to be implemented during this reporting period, with promising materials advancing to the next stage. In Uganda, sweetpotato genotypes currently used as parents in crossing blocks A and B in Uganda were evaluated in three sites (10 plants per plot, 3 reps, RCBD). Across locations and seasons, the mean SPVD score was 2.4 with 106 (81.5%) of the parents showing SPVD field resistance with a mean score of less than 3 at Namulonge (1- No virus to 9- serious virus). Mean storage root yield for the parents across locations and seasons was 9.4 t/ha, while the foliage yield was 30.8 t/ha. The overall performance of these parental genotypes across all the environments can be an indicator of good parents, however, the parent-progeny testing will enable us to ultimately eliminate the bad parents for the SPVD resistance population.

Across the multi-locational trials (MT) in Mozambique, commercial root yield increased by 0.18 t/ha on annual basis from the year 2005 until 2018. Beta-carotene, iron (Fe) and zinc (Zn) (all measured using NIRS) had yearly increments of 5.91 (P=0.0051), 0.199 (P=0.0037) and 0.116 (P=0.0252) mg/100g, DW respectively, in the MT24. A study to assess nutritional quality differences between peeled and unpeeled sweetpotato was undertaken in the Mozambique quality laboratory. The no-peeling treatment had significantly higher levels of β-carotene, Fe, Zn, and sucrose. These studies will inform the best way to consume OFSP to maximize micronutrient intake.

The Fe-enhanced clone (MUSG15052-2) identified in Mozambique in Y3 was evaluated by ETH-Zurich for vitamin C content and confirmation of Fe content. They agreed that we could proceed with a multiple meal-feeding trial. Several months were spent negotiating with an implementing health partner in Mozambique, which did not work out. In May, a decision was made to transfer the trial to Malawi, where the local partner, the College of Medicine, is facilitating the protocols through the Ethics committee. The study is expected to start in August 2018.

At the SSP-WA in Ghana, separation of northern and southern selection efforts has led to rapid identification of a cohort of promising genotypes for the North and some with adaptation to the South. During the past year, 3 varieties were released in the North (orange-, purple-, and white-fleshed) and 2 in the South (yellow- and cream-fleshed). A large experiment to identify and separate heterotic groups from the SSP-WA breeding population-based progeny performance and genetic distance is underway. This year Ghana began using various e-tools to improve efficiency and reduce errors in data collection.

From 18-26th of January 2018, Wolfgang Grüneberg and Raul Eyzaguirre from HQ conducted a workshop for data curation and statistical analysis for CIP breeding platform leaders, postdocs, and assistant researchers at Kumasi, Ghana. In addition, efforts continue to integrate the related collection and analysis tools known as HIDAP and Sweetpotatobase and use of barcode labels for improving efficiency and accuracy of data collection and analysis. Breeders attending that annual *Speedbreeders* meeting June 2018 received training on the use of these applications, including the field book for collecting data using hand held tablets. The design proposed by Westcott (1981) is being used for all observational trials (OTs) in SASHA, and randomizations, field plans, and field books for this design are now integrated into the HIDAP analytic program.

RP2. Weevil Resistance. There were no activities for RP2 in Y4 because we decided in Y3 that the amount of *Cry* protein accumulating in the storage roots was not high enough to confer significant level of weevil resistance.

RP3. Seed Systems. Concerning **technology improvement**, a revised **net tunnel** brochure drawing on completed validation research was launched at the annual 2017 Sweetpotato for Profit and Health Initiative (SPHI) meeting. At the meeting, training materials for scaling **Triple S** were launched that included a guide for trainers, flip charts for use by extension workers when training farmers, and hand-outs for farmers. Triple S is being validated and, or scaled up in nine countries, with complementary support from other projects. In Tanzania, financial cost benefit analysis has been completed for **the irrigated vine multiplication** field trials. Preliminary analysis indicates that i) cost of production per cutting under net tunnel was more effective than open field multiplication; ii) 10 kPa[1] water tension is more cost effective as compared to 40 & 70 kPa. This implies that higher water use leads to more cost-effective vine output because of the substantially greater vine yield. **Sandponics:** The financial cost–benefit analysis of the 2017 experiment to compare vine production under conventional and sandponics systems (using a nutrient solution with nitrogen level of 150 ppm) concluded that the current sandponics protocol was not cost-effective compared with the conventional method. A review of the findings indicated that the number of ratoons and nutrient solution in sandponics needed to be optimized. Further experiments to study the effect of sequentially increasing levels of Nitrogen (N), Phosphorus (P), Calcium (Ca), Sulphur (S) and Boron (B) on sweetpotato vine yields in sandponics were conducted March to May 2018. Results were used to refine the nutrient media for vine multiplication under

[1] kPa (Kilo Pascals) is a measure of water tension, with lower values indicating higher water utilisation.

sandponics. A new experiment to compare cost benefit of vine production under conventional and sandponics systems using the optimized sandponics media started in Kenya (June 2018).

Technical production and financial capacity for pre-basic and basic sweetpotato seed production. Screenhouse or mobile net tunnel production capacity ranges from 67 m^2 (IIAM) to 1,396 m^2 (Tanzania at three stations). Production of 413,607 (first 6 months); 803,043 (total for Y4) pre-basic and 2,535,494 (first 6 months); 4,918,964 (total for Y4) basic three-node cuttings was reported[2]. The national agricultural research institutes (NARIs) started implementing the business ("biz") plan financial templates, which link customer seed requirements, unit production costs, and availability of funds from the revolving fund and SGAs. The goal is that the **revolving fund** can sustain early generation seed (EGS) production by December 2018. All 12 NARIs reported revenue into their revolving funds during Y4. High performers (reporting revenue of above $10,000) are: SARI, SRI and KEPHIS. The low performer with revenue below $3,000 for the year is CRI. Medium performers (between $3,000 and $10,000) are: RAB and ZARI. Unfortunately, at the time of this report, sub-grantees IIAM, INERA, NaCRRI, TARI and DARS have not turned in their required reports on the rotation fund status.

The **peer-to-peer review study to validate the EGS business models** and to assess the level of institutionalization of the business plans and revolving funds has now been completed for the Kenya Plant Health Inspectorate service (KEPHIS) (peer review by the Crops Research Institute, CRI); the Rwanda Agricultural Board (RAB) (peer review by KEPHIS) and the Environmental Institute for Agricultural Research (INERA), Burkina Faso (peer review by RAB). The study assesses the level of institutionalization based on four pillars (technical, administration and finance, socio-cultural and policy) which all contribute to the sustainability of the business. Results to date show that the administrative/financial pillar consistently scored low. The factors which contribute to low scores for this pillar indicate that more attention is required at the institutional level to: budget EGS production costs *from* the revolving fund; ensure timely planning for procurement; and maintain and use customer data bases to update seed requirements. During the peer visits, the findings are used to develop a set of strategies using a "Strengthens, Weaknesses, Opportunities, and Threats" (SWOT) analysis for NARIs to improve their weakest pillars and sustain their sweetpotato business in the long-run. The visits to another four NARIs will be completed (to make a total of seven of the twelve NARIs) by the end of 2018, with write up in early 2019.

Research to **test and document models for medium- to large-scale basic seed production (the "missing middle")** is ongoing in Uganda, Tanzania, and Ethiopia, as are associated studies to address technical questions relating to rotation practices and isolation distances. Findings from the **sweetpotato-rice rotation study** indicates that rotating sweetpotato, principally for planting material, with rice in irrigation schemes outcompetes growing them as monocrops. After four seasons (three rotations), the net profit ratio in the treatment (rotation) was significantly and positively higher by 0.43 than in the control group (separate monocrops).

Given the many projects have used variants of creating networks of famers trained to multiply planting material, a study was undertaken in Uganda and Tanzania from December 2017 through February 2018 to: 1) **identify financially viable vine multiplication models**; and 2) to determine the number of vine multipliers needed to adequately supply clean sweetpotato vine in Uganda and Tanzania. Key findings include:

1) When assumptions of the recommended agronomic practices were applied, rapid vine multiplication remains financially feasible, but the conventional vine multiplication (vine + roots) is not.

2) The study found that multiplication of vines without using protected structures is more financially sound than when vine multipliers maintain the protected structures in vine multiplication.

3) Multiplication of vines in the low SPVD areas is more profitable than in the high SPVD areas, due to higher demand generated by drier conditions affecting the ability of smallholders to retain their own seed.

[2] KEPHIS and INERA only produce & sell pre-basic; SARI, IIAM produce pre-basic which is then used to produce and sell basic seed. Other NARIs produce and sell pre-basic and basic seed.

Ten countries have drafted **seed standards** for sweetpotato (where none previously existed) or have revised existing seed standards (e.g., Malawi). The seed standards for Ethiopia, Rwanda, Kenya and Tanzania (formal seed classes only) have now been officially approved (gazetted). This has been done in consultation with key stakeholders and with support from different organizations (e.g., CIP, HarvestPlus, University of Makerere).

Research on determining the potential importance of **sweetpotato begomoviruses** continued. A total of 896 samples were collected across Kenya and 167 tested positive to begomoviruses by polymerase chain reaction (PCR). These will be sequenced by small RNA sequencing to determine virus variability. A two-season field trial using virus-tested and virus-infected with Begomovirus, sweet potato feathery mottle virus (SPFMV), and sweet potato chlorotic stunt virus (SPCSV), alone and in all possible dual combinations, using 'Kakamega' and 'Ejumula' were installed and data collection concluded at Kenya Agricultural and Livestock Research Organization (KALRO)–Kiboko. Analysis is on-going.

Diagnostic tools. A fourth iteration of **ClonDiag** was designed by FERA Science Ltd (FERA) with improved performance and newly discovered viruses. The following viruses can now be detected: cucumber mosaic virus (CMV), SPCSV, sweet potato virus 2 (SPV2), SPFMV, SPVG, SPVZ, sweet potato mild mottle virus (SPMMV), sweet potato collusive virus (SPCV), sweet potato vein clearing (SPVCV), SPC6V, SPPV, SPSMV, sweet potato chlorotic fleck virus (SPCFV), sweet potato latent virus (SPLV), sweet potato leaf speckling virus (SPLSV), sweet potato mild speckling virus (SPMSV), sweet potato leaf curl virus (SPLCV) ipomoea yellow vein virus (IYVV), tobacco mosaic virus (TMV), and tobacco streak virus (TSV). A smartphone app is now functional to analyze the result from the arrays. The correlation between array results and traditional indexing has been validated to be 100% for infection status (i.e., plants infected by at least one virus) using 25 plants with confirmed virus status. One more round of validation remains to be conducted in year 5.

The **thermostabilized loop-mediated isothermal amplification (LAMP)** test for SPVD and begomoviruses is now in a ready-to-use form, with user-friendly disease detection technique and requires no cold chain. We envisage that the portable LAMP device will be used in seed systems diagnostic and regulatory functions across SSA countries. Primers for SPCSV and begomoviruses were redesigned to improve performance, but only the begomovirus one functioned well. Further revisions are underway.

Fingerprinting all released and elite materials at SSPs to ensure correct identity and remove duplicates. The final collection of the best-bet variety characterization consists of 111 clones/varieties from 16 African countries. All varieties have undergone virus cleaning by meristem tip culture and thermotherapy. These will be virus tested, indexed and conserved in-vitro tissue culture and in-vivo in screenhouses. One hundred of these varieties have been sampled for genotyping by SSRs markers at BecA–ILRI Hub. In addition, DNA samples were sent to Diversity Array Technology for single nucleotide polymorphism (SNP) and DArTseq analysis. Ninety-eight varieties of best-bets were planted at KALRO–Kiboko in April 2018 for phenotypic assessments. Data were collected at 90 days after planting (DAP) for 33 descriptors, including photographs. Roots will be sent to CIP-Uganda for quality characterization using NIRS at 120 DAP. An online best-bets catalogue will be produced before the end of 2018.

RP4. Postharvest and Nutritional Quality. The Natural Resources Institute (NRI) leads fresh root storage trials in Kenya. This year focused on the construction of a new solar-powered system with a cooling system that could get the temperature to lower—at least to 15°C—which would prevent weevil outbreaks and sprouting that occurred when using the evaporative cooling facility tested in year 3. The first trial in initiated in October 2017 failed due to a problem in heat management during storage. Before initiating another round in Kenya, small studies were carried out in the UK which determined that the best temperature for curing using Kabode was 28°C and optimized airflow to ensure homogeneity of storage temperature and humidity. The next storage four-month trial began in February 2018. Although the store was able to maintain temperature and humidity within the target range, the percent of root material suitable for processing after 4 months was less than for the trials carried out using the evaporative cooling store for which the storage temperature was higher (20 - 22°C). Upon reflection, NRI suggested that managing ventilation better in the air-conditioned facility to prevent CO2 build-up is likely to lower losses.

An initial analysis of the cost and efficiency of the two storage types used so far has been completed. The solar-powered air-conditioned system currently has a break-even price of 478 USD/ton compared to the 485 USD/ton for the national grid system (assuming there were no breakdown causing reliance on a generator) versus 409 USD/ton for the evaporative cooling system. These prices are 3 to 3.5 times higher than the cost of the roots at harvest time. The high cost is driven by the loss rate being 25% in all systems. Clearly, loss rates need to be lowered.

During Y3, the RP4 team achieved its goal of a shelf-storable OFSP puree that could store at room temperature for 4 months using locally available preservatives. During year 4, two experiments were carried out with the shelf-storable puree. The first looked at bread made with puree stored for 3 months, using two different preservative combinations and substitution rates of 30% and 40% of wheat flour. At a substitution rate of 40%, the bread provided up to 58.03 ±3.90 µg retinol activity equivalents (RAE) 100/g, making it a good but not excellent source of vitamin A. The second study revealed that consumers found all the bread samples acceptable.

This year the Food Analysis and Nutrition Evaluation Laboratory (FANEL) continued to serve various projects, analyzing many OFSP products from Malawi and conducting a study comparing the ß-carotene content of OFSP puree vs. OFSP flour and fresh OFSP roots. During this reporting period, FANEL conduct 1,782 ß-carotene analyses; 729 vitamin C analyses; 582 proximate analyses; and only 30 yeast and mold assessments (see Appendix E).

Three master students in the Food Safety and Quality Management at University of Nairobi graduated in 2017, having worked on various OFSP-related projects in FANEL. In 2018, all three published their findings. FANEL also hosted Dr. George Okoo Abong', senior lecturer, Food Science Department, University of Nairobi, who researched bioactive components in sweetpotato leaves and roots including OFSP and in-vitro glycemic index for OFSP processed products. A doctoral student completed her laboratory work on bioaccessibility of carotenoids in OFSP supplemented products.

The effect of packaging material and storage condition on carotenoid content of OFSP flour made from the varieties 'Vita' and 'Kabode' was investigated. A total of 100 g of flour was packed in Kraft, HDPE, and AFL paper and stored under light:dark conditions to study the effect of packaging material on carotenoid degradation over a 4-month storage period. The study found that AFL is the most suitable packaging material for OFSP flour.

From 4 to 8 December 2017, FANEL and NRI hosted a regional workshop for 27 participants (12 women) on OFSP food processing and food safety at BecA. The aim was to enhance compliance with food safety regulations by small-scale enterprises involved in the processing of roots, tubers, and bananas in SSA (Milestone Report OBJ4MS4.1.A).

RP5. Support Platforms, Knowledge Management, and Governance. The 8th Annual SPHI technical meeting took place on 24–26 September 2017 in Dar-es-Salaam, Tanzania (Milestone Report OBJ5MS1.2.H). The theme of this year's meeting was **'Building Resilient Food Systems with Sweetpotato**.' The meeting incorporated a half-day exhibition held at Mlimani City Mall, a popular shopping mall in Dar-es-Salaam, on 24 September with more than 500 attendees. The next two days, 105 participants (64 men, 41 women) representing 42 distinct organizations drawn from 16 countries in SSA, along with Germany, Peru, the United States, and Britain, participated in the technical meeting. This was followed by a field trip to visit several sweetpotato dissemination and training efforts in Tanzania. In preparation for the meeting, 17 SASHA update briefs and 29 non-SASHA project update briefs were prepared (compared with 39 briefs the previous year). In addition, we launched the 39-page OFSP Passport to Good Health, which contains key facts about OFSP and contact information. The first year of Excellence in Sweetpotato Awards was presented, $500 for best scientific paper and $500 for best communication for change product.

The monthly E-digest sent out by email continues to direct recipients to new information on the Sweetpotato Knowledge Portal (SKP). At the end of year 4, the SKP had 661 registered users and 2,050 files; 47 projects are listed on the SKP as well. The number of sessions on the SPK increased from 24,825 the previous year to 35,069 this year; and the percent of sessions accessed using mobile phones from 21% to 41%. A monthly E-digest, highlighting new items on the SKP, is sent out to 1,706 subscribers. A dashboard feature added to the SKP provides users with graphic representation of the number of beneficiaries reached under the SPHI by country and by organization, the number of varieties released since 2009 and characterized by key traits, and information on the gender and location of decentralized vine multipliers. There was substantial increase in the use of our Facebook and Twitter sites due to a concerted effort made by the new SASHA communications officer.

By end of December 2017, 4.5m households had received improved sweetpotato varieties according to dissemination records of the Sweetpotato for Profit and Health (SPHI) partners. Finally, a communications intern produced three 6-min videos, two on Triple S (introduction and training videos) and one on the process of making OFSP puree and bread in Kenya. KEPHIS also produced a video on disease-free planting material production at their Muguga Station.

II. Main Progress Report (1 July 2017- 30 June 2018)

A. RP1: Breeding (details provided in Appendix C)

The overall breeding objective under SASHA2 is to ensure that sweetpotato breeding programs efficiently produce superior varieties to serve producer and consumer needs for food and nutrition security, fresh markets, diversified nutrition value chains, and processed products for expanding urban populations. Population development is conducted at support platforms in Uganda, Mozambique, and Ghana, with backstopping from CIP-HQ. Work is done in an integrated and collaborative fashion with national partners to ensure efficiency of breeding efforts. Specific breeding objectives are to (1) continue to improve sweetpotato population development in SSA through the validation of improved breeding methods, linked with participatory varietal selection at national level; (2) breed for key biotic constraints in Africa; (3) breed OFSP populations for drought-prone regions in Africa; and (4) breed quality types of sweetpotato for urban markets. Heterosis exploiting breeding schemes (HEBS) and repeated recurrent selection (RRS) are combining outbreeding and inbreeding, and the hypothesis is that they can considerably improve genetic gains (GG) in sweetpotato. This report details achievements for each of the breeding objectives in year 4 of SASHA Phase 2. Of the 10 breeding milestones, one is achieved; one is almost achieved, and the remaining 8 are on track (see Appendix A for details).

At CIP-HQ (Appendix C1), breeding focuses mainly on addressing objective **MS1.1.2: Estimates of yield gains achievable by repeated recurrent selection (RRS) in sweetpotato**. The HQ breeding team also backstops efforts of regional breeders and the global community of practice (CoP) through strategic leadership and statistical backstopping. During Y4, good progress continued on Milestone 1.1.2, whose objective is to develop and validate strategies for heterosis exploitation by the end of SASHA2. This CIP-HQ progress report covers (1) experimental heterosis populations, (2) improvement of statistical analysis of heterosis studies, (3) GG studies, (4) capacity building to improve field trail designs and statistical analysis, (5) SPVD-resistance breeding, and (6) collaboration with Advanced Research Institutions (ARIs).

(1) Experimental heterosis populations: In 2017, H1 hybrid populations were evaluated together with the foundation and baseline grandparents, respectively (49 PJ and 31 PZ) and new parents (42 PJ' and 42 PZ' parents for wide adaptation & earliness (WAE), 25 PJ'' and 28 PZ'' parents for non-sweet sweetpotato (NSSP), and 23 PJ''' and 23PZ''' parents for high iron (HIFE) in experiments to determine genetic gains due to heterosis increments and recurrent selection. In total, numbers of offspring families in H1 were 742 for WAE, 336 for NSSP, and 272 for HIFE. In all H1 populations, large genetic gains were observed. In H1 populations storage root yield genetic gain estimates ranged from 68.8 to 110.3%. Heterosis increments for storage root yield in hybrid population H1 ranged from 9.3 to 37.6%. All H1 populations exhibit variety ability. These H1 studies at CIP-HQ provide useful information for (i) SPVD resistance breeding at the breeding platform Namulonge, (ii) selecting testers and elite crossings in sweetpotato population hybrid breeding, and for genome wide prediction in sweetpotato.

(2) Improvement of statistical analysis of heterosis studies: A CIM/GIZ integrated expert position at CIP in plant breeding statistics has been created at CIP-HQ and Dr. Bert De Boeck from Belgium (a mathematician with a PhD in statistics) will start at the 6th of July 2018 in Lima on this position. The 8x8 cross from Uganda evaluated in Uganda has been completely analyzed as a 9x6 design. For storage root yield, very large mid-parent mid-offspring heterosis increments for UG_A x UG_B were observed with an average of 93.2%.

(3) Genetic Gain (GG) Studies and Breeding Progress with new Sweetpotato Varieties: Genetic gains are currently estimated by CIP as "Modified Demonstration Trials" (MDT). The GG studies in the humid tropics of the Amazon basin have been carried out at two locations (San Ramon and Satipo) and across two years and seasons, respectively. It was estimated that the GG for storage root yield, number of commercial roots per plant, and foliage yield for 90 days harvest in the Amazon basin are 240 kg/ha, 0.023, and -30kg/ha per annum with an intercept of 5.9 t/ha, 0.57, and 36.6 t/ha, respectively. The corresponding estimates of GG in the Amazon basin for normal harvest (120 days) are 460 kg/ha, 0.040, and -95kg/ha per annum with an intercept of 9.8 t/ha, 0.82, and 33.6 t/ha, respectively. We observe a pronounced increase in storage root yield associated with a slight decrease in foliage yield for released varieties across the past 20 years.

(4) Field trials & other methods: The design proposed by Westcott 1981 is used for all observational trials (OTs) / population evaluation trails in the SASHA project and randomizations, field plans, and field books for this design are integrated in the program HIDAP. We have implemented several modifications with respect to the original analysis of the Westscott design in the program HIDAP, such as distance of plot to be adjusted to the six nearest check plots. We bought in SASHA2 year 3 three portable equipment "BRIX" to estimate sucrose in fresh sweetpotato storage roots. Unfortunately, this equipment has not produced consistent results for cooked storage roots.

(5) Progress in SPVD resistance breeding: The milestone enhancing the of frequency of SPVD resistance from less than 0.2% to 2% in breeding at Namulonge remains critical. We are targeting the problem by four different approaches:

Approach 1: Search for less SPVD susceptibility in advanced breeding lines and varieties with good agronomic performance followed by intensive recombination: In total 61 + 8 clones have been recombined (351 families, total 12,163 seed). Seeds from these crosses are in the process to be shipped to Ghana to test if this material also exhibit a degree of SPVD resistance in West Africa at least in northern Ghana and Burkina Faso.

Approach 2: Pre-breeding with germplasm resources exhibiting confirmed SPVD resistance associated with weak agronomic performance: Material has been evaluation for performance in field trials (441 clones tracing back to 72 families) in the humid tropics of Peru at San Ramon and Satipo. Clones considered as resistant to *Sweetpotato Chlorotic Stunt Virus* (SPCSV) are (N=24): VJ08.330, PJ05.064, xVJ11.028, xVJ11.029, VJ11.034, VJ11.042, VJ11.043, VJ11.044, VJ11.045, VJ11.046, VJ11.047, VJ11.048, VJ11.050, VJ11.051, as well as VZ08.025, VZ08.124, VZ08.131, VZ08.263, VZ08.312, VZ08.338, VZ08.339, VZ08.451, VZ08.483, VZ08.484). Since May 2018 we are conducting a 9x9 cross design with eight resistant clones and one susceptible clone. For SASHA 2, year 10 the true seed of these crosses will be germinated in-vitro and in-vitro plantlets will be send to Uganda. We will conduct the DArT marker validation so far found to be associated with resistance to SPCSV in Uganda (see below).

Approach 3: Identification of Molecular Marker Associations and Validation: In total, 13 DArT markers have been found so far in association to SPCSV or SPVD, respectively (Appendix C1 for details). We are in the process to apply these 13 markers available for validation to the parental material in use at Namulonge in combination with the information about SPVD resistance of these clones by Robert Mwanga. The DNA of these parents are available at CIP-HQ. Moreover, the 9x9 cross design with eight resistant clones and one susceptible clone (see above) shall be used for validation of these 13 DArT markers.

Approach 4: Offspring testing in combination with implementation of HEBS at Namulonge / Uganda: A H0 hybrid population of genepool UG_A and UG_B is in field evaluation at Namulonge / Uganda to obtain data to select parents on basis of offspring performance with emphasis on SPVD and yield (see report East African breeding platform).

(6) Workshops, Collaboration with Advanced Research Institutions (ARI), and Publications: CIP-HQ scientists conducted from 18-26th of January 2018 a workshop for data curation and statistical analysis for CIP breeding platform leaders, postdocs, and assistant researchers at Kumasi, Ghana. For heterosis exploiting breeding schemes we are co-operating with the IPK Gatersleben breeding research unit lead by Jochen Reif. For multi-stage selection and accelerate breeding schemes we are co-operating informally with the University of Hohenheim and Friedrich Longin. For field trial designs we are in the process to establish a cooperation with the working group of Hans-Peter Piepho from the University of Hohenheim. We report the availability of proofs for the Crop Science publication "Gene Pool Subdivision of East African Sweetpotato Parental Material".

Sweetpotato breeding work at the **Breeding Support Platform for East and Central Africa (SSP-ECA) in Uganda** (**details in Appendix C2**) has four main milestones, with progress in each described below.

MS1.1.1. Studies demonstrating that significant genetic gain (2% per year in yield) can be achieved in 2 years in early generations and 4 years for selected varieties; and MS1.2.3. Selected hybrid progeny demonstrating yield jumps of 10–20% from populations with SPVD resistance.

Data were analyzed from field experiments conducted in 2015B and 2016A seasons with the objective of estimating sweetpotato breeding progress made in Uganda since 1995 when the first modern bred sweetpotato variety, 'Sowola' was released in Uganda. Data of fourteen sweetpotato varieties were used for the comparison, including Sowola, 'NASPOT 1', 'NASPOT 2', 'NASPOT 3', 'NASPOT 4', 'NASPOT 5', 'NASPOT 6', 'NASPOT 7', 'NASPOT 8', 'NASPOT 9 O' ('Vita'), 'NASPOT 10 O' ('Kabode'), 'NASPOT 11', 'NASPOT 12 O', and 'NASPOT 13 O'. The effect of breeding was estimated as genetic gain for storage root yield in tons per hectare per year by regressing the mean of each character for each variety against the year of release of that variety using PROC REG procedure in SAS. There is an annual rate of increase of storage root yield, estimated by the regression coefficients of 0.41 t/ha per year. This clearly indicates that breeding efforts in Uganda have had significant improvement on storage root yield over the years. Genetic gains have also been obtained for biomass (1.04 t/ha per year) and β-carotene content (0.47 mg/100g, FW per year). However, harvest index and dry matter content have been reducing at 0.3% and 0.07% per year respectively, during the breeding process. The baseline variety, Sowola, is cream-fleshed with high dry matter, 34%, but five of the released varieties are orange-fleshed with a negative genetic gain for dry matter content, although the dry matter content of all released OFSP are above 27%.

Following the heterosis trials (previously reported in 2016), 55 genotypes were selected for further evaluation at Namulonge, Serere, and Kachwekano; each trial comprised 10 plants in two rows in a randomized complete block design (RCBD) during the 2016A, 2016B and 2017A seasons. Storage root samples were obtained from the 54 out of the 55 clones for NIRS analysis. None of the families significantly (P>0.05) outperformed the improved check clone 'NASPOT 11' with respect to either storage root yield or field resistance to SPVD, although several individual clones outperformed NASPOT 11. Despite the effects of prolonged drought for these trials in 2016 A and 2016 B, eight genotypes combining orange-fleshed roots with high storage root yield potential, low SPVD, Alternaria blight and weevil damage scores, were selected and planted in new advanced yield trials planted in 2017B trials. These were D30 (storage root yield, 8 t/ha), D26 (11.2 t/ha), D15 (9.3 t/ha), S047 (16 t/ha), D11 (15.3 t/ha), S010 (11.1 t/ha), S097 (15.9 t/ha) and S036 (24.7t/ha). The overall mean dry matter content of the genotypes was 32.2% and β-carotene equivalent of 5.5 mg/100g. Root dry matter yield was highest for the genotype S014 (8.1 t/ha) while genotype S044 had the highest iron content of 2.9 mg/100g on a fresh weight basis (NIRS analysis).

Sweetpotato genotypes currently used as parents in crossing blocks A and B in Uganda were evaluated in three sites (10 plants per plot, 3 reps, RCBD). Across locations and seasons, the mean SPVD score was 2.4 with 106 (81.5%) of the parents showing SPVD field resistance with a mean score of less than 3 at Namulonge (Maximum score is 9, indicating severe virus). Mean storage root yield for the parents across locations and seasons was 9.4 t/ha, while the foliage yield was 30.8 t/ha. The overall performance of these parental genotypes across all the environments can be an indicator of good parents, however, the parent-progeny testing will enable us to ultimately eliminate the bad SPVD parents. Lsmeans for Namulonge (the high SPVD pressure site) were used to compute the mid-parent values to select the best cross combinations for SPVD resistance, storage root yield and β-carotene content for product (variety) development for eastern and central Africa. Forty-five parents (21 from population Uganda A and 24 from population Uganda B have been selected; performance of the progeny from crosses of the selected parents under field evaluation in 2018 will indicate the parents good for breeding for SPVD resistance.

MS1.1.3. At least 14 African sweetpotato breeders breed using the latest knowledge and efficient methods.

As previously reported, 14 African countries now have crossing blocks and some are implementing the accelerated breeding schemes (ABS) with increasing interaction with the sweetpotato breeders across the globe. This year (2017/2018), six countries (Uganda, Burundi, Ghana, Malawi, Madagascar and Ethiopia) released 22 varieties, nine of the varieties were new releases (either bred or selected from seed) and 11 varieties (50%) were orange-fleshed.

Under SASHA2, Burundi and Madagascar receive limited support by BMGF for their varietal selection efforts. Burundi is one of the countries gaining ground with sweetpotato breeding, after establishing a crossing block (33 parents), an observation trial to evaluate progenies from the crossing was planted in February 2018. This comprised 15 polycross families and 40 controlled cross families. Burundi has also submitted six OFSP candidate clones (Amelia, Irene, SPK004/2006/1136, NASPOT 9 O, Bwanjule and Mayai) for national performance trials (NPT).

MS 1.2.1: At least 250,000 seeds with increased frequencies of resistance to SPVD (2–10%) disseminated to at least 10 NARS partners.

True sweetpotato seed was generated by polycrosses and controlled crosses from the parents within and between the two crossing blocks (population Uganda A and population Uganda B). During the current reporting period (July 2017–June 2018), 217,469 poly-cross seed (81,483 and 135,986 from crossing blocks A and B, respectively) were generated. During the same period, 59,076 controlled cross seeds were generated from the two crossing blocks. Most of the controlled cross seeds were germinated to generate progenies for two observational trials planted in the 2018A season: 1) to validate increase in SPVD resistance from the parent-offspring analysis, i.e. progeny from nine SPVD resistant parents and 2) to eliminate bad SPVD resistance parents i.e. from the 80 x 50 parents.

Progress continued at the **Breeding Support Platform for Southern Africa (SSP-SA) in Mozambique.** Details are shown in Appendix C3 on progress for its four main objectives, which is briefly described below.

MS 1.1.1 Studies demonstrating that significant genetic gain (2% per year in yield) can be achieved in 2 years in early generations and 4 years for selected varieties

Trials to search for new sources of drought tolerance and estimation of genetic gains made by the breeding program were established and harvested between July 2017 and June 2018. The trials were observation trials (OTs), preliminary yield trials (PTs), advanced yield trials (ATs) and multilocation trials (MTs) at Umbeluzi, Gurue and Chokwe Research Stations. The population mean for percent dry matter (DM) of the MTs was above 30.38% an indication of improvement from population means of varieties released in 2011 and 2016. Two clones, MCKSL13004-146 and MCKSL13004-147 had good combinations of beta-carotene, Fe and Zn in the MTs. MCKSL13004-146 and MCKSL13004-147 had 25.93, 2.6, 1.58 & 30.84, 2.48, 1.38 mg/100g, DW of beta-carotene (BC), Fe and Zn, respectively. In the MTs, commercial root yield increased by 0.18 t/ha on annual basis from the year 2005 until 2018. Beta-carotene, Fe and Zn had yearly increments of 5.91 (P=0.0051), 0.199 (P=0.0037) and 0.116 (P=0.0252) mg/100g, DW respectively, in the MT24. In ATs, the check clones 199062.1(22.18 t/ha), Namanga (20.63 t/ha), Irene (20.64 t/ha) and Tanzania (6.99 t/ha) were significantly out yielded by the 11 experimental clones (31.62 t/ha). The population means for the new clones significantly outperformed the population mean for check varieties used in the trial for commercial root yield and vine yield with a low increase in the beta-carotene content. The highest vine yield was recorded on MUSG15013-8 (45.6 t/ha) and MUSG15047-20 (40.3t/ha) which were significantly higher than Irene (36.0 t/ha), the best check clone. The highest BC content[3] was 12.59 mg/100g DW for MUSG15040-9.

MS 1.3.1. At least 150 thousand seeds with drought tolerance genes disseminated to at least 10 NARS partners in SSA and SWCA

Two distinct OFSP breeding populations are maintained in Mozambique, with separate crossings blocks established at IIAM stations in Umbeluzi. An additional, a mini-block with purple-fleshed clones is also maintained in Gurue. The major theme of the breeding program is drought tolerance and all parents for OFSP improvement program are selected based on history of drought tolerance, beta-carotene content, dry matter levels, and Fe and Zn contents. A summary of the productivity of 2017 crossing blocks is as follows: **24,463** botanical seed (326 families) from controlled crosses and **145,554** botanical seed (64 families) from polycrosses were harvested at Umbeluzi Research Station. In Gurue, **38,894** botanical seed (347 families) were harvested from controlled crosses in the OFSP crossing block while **69,797** botanical seed (63 families) were harvested from ploycrosses in the same crossing block. From

[3] Based on color chart values.

the PFSP crossing block established in Gurue, **21,467** botanical seeds (257 families) from controlled crosses and **42,734** botanical seed (47 families) from polycrosses were harvested. From the controlled crosses, **3,000** (150 families) were germinated in Maputo and a seedling nursery established in preparation of new OTs at Umbeluzi. A germination percentage of 97.18% was achieved in the seedling nursery. Another lot of **3,000** botanical (150 families) seed from controlled crosses made in Gurue in the OFSP crossing block were scarified and germinated. A total of **2,400** botanical seed (120 families) from the PFSP crossing block were also scarified and a nursery established in Gurue for new OTs. About **10 c**uttings of 30 cm length for each of the released varieties, Amelia, Bela, Cecilia, Delvia, Erica, Esther, Gloria, Irene, Ininda, Jane, Lourdes, Melinda, Namanga, Sumaia, Tio Joe, Alisha, Bie, Bita, Caelan, Lawrence, Ivone and Victoria were sent to NARS partner in Malawi, Bvumbwe Station on 27 March 2018. A total of 441 cuttings of 30 cm length each for Alisha, Bie, Bita and Olympia were sent to Nairobi for trial establishment in April 2018. A total of 5,000 true seeds from 50 families harvested in 2017 from polycrosses at Umbeluzi Research Station were sent to Brazil, CERAT, UNESP, Câmpus de Botucatu, in March 2018. Another set of true seeds were distributed to NARS partners from Burkina Faso, Burundi, Rwanda, Cote d'Ivoire, Nigeria, Zambia, Kenya, Ghana, Malawi, Ethiopia, South Africa and Madagascar during the breeders meeting in June, Nairobi, Kenya. Each NARS partner received 3,000 true seeds. This milestone is fully accomplished.

MS 1.3.3. Hybrid progeny exhibiting yield jump of 10 to 20% in hybrids from populations with drought tolerant & enhanc efficiency for drought tolerance breeding

Botanical seed (**3,769** and **3,301** clones) from the two distinct OFSP breeding populations generated from controlled crosses at IIAM stations at Umbeluzi and Gurue, respectively, were evaluated at Umbeluzi and Gurue under irrigated and not irrigated treatments. A total of **2,149** clones from the PFSP mini-block were evaluated at Gurue under two water treatments (well–irrigated and not irrigated). There was a clear genetic gain on the commercial storage root yield and vine yield observed on OTs harvested at Umbeluzi Research Station in December 2017 when population means were compared between the new experimental clones and check clones (Resisto & 199062.1) and/or their progenitors. At Gurue Research Station, gains were observed in the orange-fleshed population for commercial root yield, whereby the new clones had higher population mean than the mean of their progenitors. In the purple-fleshed population, significant improvement was observed on the vine yield where the new clones had higher population mean than the check clones or their progenitors. Based on root shape, size, resistance to weevil damage, vine yield, vine vigor (≥7) mainly thick stemmed, and root yield (>1.5 kg per 3 plants), 436 clones orange-fleshed were advanced to PTs from the OTs established at Umbeluzi and Gurue.

MS 1.3.4 Clones with 200% RDA for young children of pro-Vitamin A, 25% RDA of iron and 35% RDA of zinc under high intake intakes

Three crossing blocks are maintained at IIAM sites in Gurue and Umbeluzi. The parents are continuously selected based history of drought tolerance, beta-carotene content, dry matter levels, Fe and Zn contents. About **9,571** clones were processed in the quality laboratory and 60% of the clones have complete data sets (DM, BC, Fe, Zn, Starch, and the reducing sugars). The OTs planted and harvested from November to December 2016 had clones high and Fe and Zinc by NIRS analysis. More than 200 clones were identified from the OT planted at Umbeluzi in 2016 and sent for verification of Fe and Zn through XFR in Lima; then the top 30 to Australia for confirmation of no contaminants using the ICP. Per our milestone, our clones should provide a target of 25% RDA of iron (2.4 mg/100g DW) and 35% RDA of zinc (1.2 mg/100g DW) under high intakes. Several clones were high in Fe using the XFR analysis but one clone, MUSG1505-2 with sufficient levels of iron, and confirmed not to be contaminated with soil iron, was selected for multiple meal testing. The general agronomic characters of this clone are, storage root yield (27.8 t/ha), foliage yield (32.1t/ha), dry matter (23.1 %), beta-carotene (35.08 mg/100g, DW), Fe (38 mg/kg, XRF; 44 mg/kg, ICP). Root samples of the Fe-enhanced clone and two released, lower Fe content varieties were sent to ETH Zurich for confirmatory analysis of Fe content and to determine the level of phytate (a potential inhibitor) and ascorbic acid (an enhancer of iron absorption). MUSG1505-2 had higher Fe & Zn than Sumaia and Irene. However, it had lower Vitamin C than the two varieties. Multiplication of MUSG1505-2 was started at Umbeluzi for the feeding trials and now ready for harvesting, the storage roots will be sent to Malawi for the feeding trial.

Another multiplication was initiated in June 2018 at Nwalate Farm. A study was taken to assess nutritional quality differences between peeled and non-peeled sweetpotato. A total of 15 released OFSP varieties and an elite clone, Anamaria were used for this study. The OFSP released varieties included; Alisha, Amelia, Delvia, Esther, Gloria, Ininda, Irene, Ivone, Jane, Lawrence, Lourdes, Melinda, Namanga, Resisto and Victoria. The dry matter, fructose, glucose and protein contents were not affected by the treatments applied (peeling and no peeling). However, significant differences were observed on beta-carotene, Fe, Zn, starch and sucrose contents between peeling and no peeling treatments. The no peeling treatment had significantly higher beta-carotene, Fe, Zn and sucrose than the peeling treatment.

Breeding efforts at the **Sweetpotato Support Platform for West Africa (SSP-WA)** in Ghana have two main outputs/milestones: 1.4.1. At least 100,000 seeds with less-sweet taste genes disseminated to at least 10 NARS partners in SSA and SWCA; and 1.4.3. Hybrid progeny with yield jumps of 10–20% from less-sweet, less perishable parents. Progress toward these objectives during the last year is detailed below.

The SSP-WA is based at the CSIR-Crops Research Institute (CRI), Kumasi (Fumesua). In close partnership with CSIR-CRI and CSIR-Savanna Agricultural Research Institute (SARI), Tamale (Nyankpala), the breeding program targets regions of Ghana where sweetpotato is important. It covers the major agro-ecological zones of Ghana—Coastal Savanna, Forest zone, and Guinea Savanna—which are broadly representative of larger agro-ecologies across West Africa. The SSP-WA has the development of non-sweet varieties as its signature focus, given the significant potential that these types may have for use as a staple menu item in West African diets, as snacks (fried, roasted or boiled), or for processing into convenient products to serve rapidly growing urban populations. However, our focus is not exclusively in development of these types, but also includes breeding for various quality types and flesh colors. There is growing demand for orange-fleshed sweetpotato in both fresh and processed (puree) forms for local, regional and global markets.

The accelerated breeding scheme runs parallel selection efforts for adaptation to the northern and southern (high virus pressure) agro-ecologies, with routine evaluation across regions at the preliminary yield trial stage. With the use of dry season trials, time to release can be four years or less, while still satisfying requirements of release committees for 2 years data on-station and on-farm. The strategy of separating environments, begun in 2016, seems to be working well, and rapid progress has been made in the northern savanna zone, with clones (including very low sweet ones) selected from seed germinated in 2014 now entering the second year of on-farm testing. Somewhat slower progress in the South is probably attributable to higher virus pressure. During the past year, 3 varieties were released in the North (orange-, purple-, and white-fleshed) and 2 in the South (yellow- and cream-fleshed). Released varieties are already pathogen-tested and in the national pre-basic seed program. Linkages to seed systems and value chains, and feedback loops on performance, and demand for these varieties both nationally and regionally will help drive and provide adjustments to the orientation of the on-going breeding effort.

MS 1.4.1 At least 100,000 seeds with less-sweet taste genes disseminated to at least 10 NARS partners in SSA and SWCA. In 2017 we continued with the practice, begun in 2016, of making controlled crosses in the screenhouse using flowering vines brought in from the field. We produced over 19,000 seeds from 34 out of 48 parents and collected an additional 2,700 open pollinated seeds. Twelve hundred seeds have been distributed to 10 NARS, and an additional 10,000 are ready for distribution to Nigeria and Burkina Faso. In 2017, an MS student experimented with grafting and growth regulator treatments to boost flowering in recalcitrant parents and found that spray application of 40 ppm 2,4-D increased flowering while grafting to floriferous sweetpotato root stocks was effective at inducing flowering. This work is continuing in 2018 using best rootstock and spray combinations. We have also installed polycross nurseries at both Kumasi and Tamale to further boost seed production. In 2018, our list of parents has been expanded to 66 genotypes, an addition of 18 advanced clones over 2017. We have created wish lists of cross combinations to improve specific traits including culinary attributes (such as sweetness), flesh colors (orange, purple) and storability, and sub-populations for exploitation of heterosis (discussed below). Last year's cross combinations will not be repeated, and more effort will go into self-pollination and back-crossing advanced clones with 'old' parents.

The hybridization work is now done using various e-tools to improve efficiency and reduce errors. Genotypes in the vine multiplication field are barcode-labelled. When vines with flower buds are collected in the field, they are labeled using a mobile printer linked to field book app. In the screenhouse, the vines are put into barcode-labelled pots where they are maintained for crossing and seed production. Each pollinated flower is barcode-labelled with the name of the male. An ODK form is used to record data on pollination and seed collection by scanning the barcodes for the female and male. Using an R script, all data are summarized weekly to track progress and adjust cross combination priorities for the following week. These inexpensive tools will be shared with colleagues, other support platforms, and NARS.

MS 1.4.3. Hybrid progeny with yield jumps of 10–20% from less-sweet, less perishable parents. In 2017, we began a concerted effort to separate our parental materials into distinct groups for the purposes of exploitation of heterotic increments. To do this, we evaluated parents and full-sib progenies with sufficient numbers of individuals (seeds) to be evaluated in replicated trials. In Kumasi, we evaluated 149 families from 22 parents with at least 20 or more seeds per cross to conduct the experiment. Families with over 40 seeds per cross were also evaluated in Tamale, twenty seedlings going to each location. Progeny plots had 5 full-sib plants established from cuttings, and parents had 5-plant clonal plots. Trials were planted with 4 replications in a CRD design. Trials were laid out on a grid in the field using a nearest neighbor Westcott design with alternating 5-plant plots of 2 standard checks (Bohye – CIP 199062.1 and Ligri - Cemsa 74-228) where the yield of the standard checks distributed over the field allows for yield adjustments of experimental plots.

Mean mid-parent heterosis increments of segregating progenies were high (up to 98% for commercial yield), with values for mean performance of specific crosses ranging from -87 to 641 percent. Most cross combinations produced positive increments, though one parent CIP442162 produced negative heterosis increments. The trial included 149 families of which 82 were represented by reciprocal cross combinations. Reciprocal effects for these 41 cross combinations were significant, an interesting finding that may have consequences for breeding and seed production strategies.

We separated our population into two heterotic groups based on progeny performance by maximizing the heterosis increment between the groups.

Group A: BF92xTib.2, Blueblue, CIP440390, Jitihada, Mothers Delight, NKO31A, Nyuningre, Otoo, Hi-starch, Santompona, Tu-orange
Group B: Apomuden, BF59xCip.4, Bohye, Mbofara, Faara, Ligri, Nan, Patron, PGA13067-7, Sauti, Diedi

These groups only included the 22 parents with sufficient numbers of seeds and progenies to be involved in the heterosis assessment trial. The remaining parents will be sorted into heterotic groups based on genetic diversity assessment, which is being conducted by Mercy Kitavi at BecA using SSR markers, and through a further seedling heterosis trial being conducted this year. To validate results from the seedling nursery, the trial was repeated using the 3-plant plot observational trial approach used at CIP-HQ and other support platforms, and will be harvested shortly

If validated, use of seedling nursery experiments will allow breeders to routinely obtain information on family mean performance through easily managed trials, while selecting individual clones for advancement through the accelerated breeding scheme. Even when limited numbers of individuals per progeny or when few families per parent are available, we think that when available, routine inclusion of parents in seedling nurseries will be valuable and have implemented this approach in our 2018 seedling nurseries.

Breeding for quality is a central element of our work at the SSP-WA, with the development of non-sweet or low-sweet types of various flesh colors, for staple and alternative uses being a central focus identified during stakeholder consultations in West Africa at the beginning of the SASHA project. While we have NIRS calibrations for sugars from cooked roots, this is adequate to identify genotypes that do not generate maltose during cooking but does not help with the selection of other quality attributes. We still have not finalized what our breeding targets for non-sweet sweetpotato should be since Ghanaian consumers routinely reported liking most of the sweetpotato genotypes from our breeding program. Therefore, we set up a sensory laboratory environment, identified, trained and worked with a sensory panel to develop lexicons for boiled and fried sweetpotatoes, drawing on a range of germplasm available in our breeding populations. Preferred yam (*Discorea rotundata)* cultivars were used as a reference during lexicon development since sweetpotato tends to serve as a yam substitute in farming systems where yam cannot be grown due to poor soils and is used in the same boiled and fried forms as yam. Multivariate analysis showed broad distribution of our sweetpotato varieties over the sensorial space, and with some of the less sweet genotypes clustering with yam. We are now in the process of assessing consumer acceptance of our low-sweet and other quality types and relating this to the sensory lexicon developed by our trained panel. We are also engaging with consumers to select a preferred name for the low- or non-sweet class of sweetpotato, which will be used to assist with awareness creation, branding and promotion of this class of sweetpotato with low flavor impact, for use in fresh or fried products.

Improvement in shelf life and reduction in perishability are important additional objectives of the breeding effort. During the year, initial assessments of our parental materials by a PhD student from Sierra Leone identified genotypes with good shelf-life relative to others which shriveled or rotted rapidly. The student also worked to evaluate or develop rapid screening techniques for wound healing, resistance to scuffing, and reaction to rots (specifically Java Black Rot) and will apply this during the coming year in parent and breeding studies.

B. RP2: Weevil Resistance

Weevils, *Cylas puncticollis* and *C. brunneus*, are responsible for 28% of crop losses in Uganda, according to a farmer survey (Kiiza et al. 2009). There is currently little farmers can do when weevils infest their fields, other than to quickly harvest and salvage what is left of their crop. In addition, one of our studies has also highlighted a potential health threat when farmers consume the undamaged parts of infected sweetpotato storage roots due to high accumulation of plant toxins. Our goal is to have proof-of-concept of weevil resistance in sweetpotato roots using a transgenic approach. There are two major milestones representing distinct approaches to tackling the problem. Unfortunately, we have concluded that the *Bt* approach has not succeeded and this research is now concluded. However, the RNAi approach appears promising but needs additional resources to be able to continue. There was no additional work on this component during the reporting period.

C. RP3: Seed Systems (details provided in Appendix D)

Our vision of success for SASHA2 seed systems management is that cost-effective technologies and strategies for both male and female farmers will ensure improved access to quality planting materials. One milestone is almost achieved, three are on track, and four are behind. The delayed milestones in the area of virology research and diagnostic tools will be completed by the end of 2018. There are four major objectives linked to major milestones:

(1) Objective 3.1 aims to refine the efficiency of disease-free planting material production and better understand how virus degeneration and reversion affect specific varieties.

Low-cost net tunnel technology. The new brochure with updated and revised recommendations for the construction and management of low-cost net tunnels was completed at the start of Y4 and launched at the annual SPHI technical meeting in September 2017[4]. The brochure provides three options for materials for construction of the frame for the net tunnels (termite-proof elastic sticks, PVC tubing, or reinforcing rods) with the advantages and disadvantages of each (i.e. cost, availability of materials, and durability). The brochure also provides more details on recommended practices for weed management, irrigation, and pesticide application. More than 810 net tunnels are now in use across seven countries: Ethiopia, Kenya, Mozambique, Nigeria, Rwanda, Tanzania, and Uganda. The journal paper

[4] *Protecting Sweetpotato Planting Material from Viruses using Insect Proof Net Tunnels. A Guide to Construct and Use Net Tunnels for Quality Seed Production* (July 2017 2nd ed.).

assessing virus degeneration in net tunnels is undergoing final review by CIP's lead virologist, Dr. Jan Kreuze, before submission. These data are being used to develop a sweetpotato seed degeneration model in collaboration with the University of Florida. Another paper evaluating the technical feasibility of the net tunnel technology in Tanzania and Ethiopia is undergoing final revision.

Improved protocols for Triple S. The Triple S technology aims to improve farmer capacities and options to conserve and access quality planting material at the household level, in areas with a long dry season. In-depth research activities are being conducted in Uganda (HarvestPlus funding) and Ethiopia (SASHA funding). Triple S is being validated and scaled up in nine countries with complementary support from other projects.

Training materials for scaling Triple S were launched at the 2017 SPHI technical meeting in September 2017. These include a guide for trainers, flip charts for use by extension workers when training farmers, and hand-outs for farmers. These materials are being translated into Amharic Sidamigna, Gedioafa, Gamogna and Hadiyigna (for Ethiopia), local languages for northern Ghana, Portuguese and French. A proposal submitted to the RTB Scaling Fund was successful, with an award of $700,000 to scale Triple S, with partners in northern Ghana and southern Ethiopia. The RTB Scaling Fund will provide expertise to define and implement "theories of scaling"; the lessons from which will be applied to other contexts and technologies ready for scaling. This is an example of how research conducted under SASHA1 and SASHA2 is attracting new partners for scaling-up for broader impact. Two videos have been prepared by a media intern for advocacy and training on the Triple S technique. The training video is being voiced over in Amharic and local languages of SNNPR.

Testing irrigation methods. In Tanzania, the field work for the on-station and on-farm study to assess different types of irrigation equipment and schedules has been completed. Cost analysis was done to the determine the financial investment associated with the various irrigation approaches and benefits accrued. Initial analysis shows that: i) cost of production per cutting under net tunnel was more effective than open field multiplication; ii) it was more cost-effective to product the variety Kabode than the variety Mataya; iii) using 10 kPa water tension[5] is more cost effective as compared to 40 & 70 kPa; iv) under net tunnel and 10 kPa tension, preliminary analysis indicates that the average cost of production per cutting under drip irrigation is 66.2 TZS compared to 73.4 TZS per cutting produced under furrow, but the difference is not statistically significant. In Ethiopia, the study is continuing in collaboration with projects funded by Irish Aid and the European Union. Early results from the study to assess vine and root productivity of 8 OFSP varieties under conventional furrow irrigation techniques – have shown varietal differences for survival/establishment, vine and root productivity.

Testing cost benefits of sandponics as an alternative to conventional screenhouse multiplication. The financial cost–benefit analysis of the Y3 experiment in Kenya to compare vine production under conventional and sandponics systems (using a nutrient solution with N level of 150 ppm) has been completed. The results concluded that the sandponics protocol used was not cost effective compared with the conventional method. The reasons for this include: 1) cost of inputs (chemicals) were more expensive than the conventional method, and 2) the cost of irrigation is higher than the conventional method due to the higher frequency of irrigation required for sandponics. Consequently, further optimization of the nutrient mix was required in addition to determining the optimal number of ratoons for both methods. That is due to having was only one harvest and one ratoon crop during the 8-month study--the number of ratoons could be increased to obtain greater economies of scale.

Additional experiments to study the effect of sequentially increasing levels of Nitrogen (N), Phosphorus (P), Calcium (Ca), Sulphur (S) and Boron (B) on sweetpotato vine yields in sandponics were conducted March to May 2018. These showed a significant increase in the vine growth rate at 30 DAP when the nitrogen level was increased to 200 ppm but there is no significant difference in the overall vine length and weight at harvest (42 DAP). Results were used to refine the nutrient media for vine multiplication under sandponics. Data collection for the financial cost-benefit

[5] Kilopascals (kPA) are units of pressure measurement. Suction is a negative pressure which is also referred to as tension. Low numbers mean more water, wetter soils. They show how much suction is needed to extract water from the soil.

analysis to compare vine production under conventional and sandponics systems using the optimized sandponics media started in Kenya during June 2018.

During this reporting period, the sandponics system at NaCRRI was redesigned. A screenhouse at NaCRRI was redesigned into a sandponics system for vine multiplication to conduct experiments toward optimizing the multiplication rate and cost-effectiveness of the sandponics system. Experiments being conducted in Uganda are: 1) sequentially increasing the nitrogen levels of the nutrient solution in sweetpotato sandponics systems; 2) optimizing the number of ratoons under conventional and sandponics. When this is completed an experiment to determine the effect of gibberellic acid on sweetpotato vine yields in sandponics systems will be established.

Support to 10 national programs to improve management and oversight of quality pre-basic (foundation) seed production. Two meetings of the Seed System (SS-CoP) were held. One in November 2017 (Milestone Report OBJ5MS1.3.M) attended by the principal investigators from the 13 partners for pre-basic seed (PBS) production. The meeting reviewed progress with the implementation of the business plans and provide inputs to improve marketing strategies for seed. The second meeting hosted by RAB was held in Kigali in May 2018, with 55 from 12 countries. The theme was 'Engaging youth for improved sweetpotato seed and root production'.

Screenhouse or mobile net tunnel production capacity ranges from 67 m^2 (IIAM) to 1,396 m^2 (Tanzania at three stations). Production of 413,607 (first 6 months); 803,043 (total for Y4) pre-basic and 2,535,494 (first 6 months); 4,918,964 (total for Y4) basic three-node cuttings was reported.[6] The national agricultural research institutes (NARIs) started implementing the business ("biz") plan financial templates, which link customer seed requirements, unit production costs, and availability of funds from the revolving fund and SGAs. The goal is that the revolving fund can sustain early generation seed (EGS) production by December 2018. All 12 NARIs reported revenue into their revolving funds during Y4. High performers (reporting revenue of above $10,000) are: SARI, SRI and KEPHIS low performers with revenue below $3,000 for the year are: CRI. Medium performers (between $3,000 and $10,000 are: RAB and ZARI. We are awaiting to receive figures from IIAM, INERA, NaCRRI, TARI and DARS.

The peer-to-peer review study to validate the EGS business models and to assess the level of institutionalization of the business plans and revolving funds has now been completed for the Kenya Plant Health Inspectorate Service (KEPHIS) (peer review by the Crops Research Institute, CRI); the Rwanda Agricultural Board (RAB) (peer review by KEPHIS) and the Environmental Institute for Agricultural Research (INERA), Burkina Faso (peer review by RAB). The study assesses the level of institutionalization based on four pillars (technical, administration and finance, socio-cultural and policy) which all contribute to the sustainability of the business. Results to date show that the administrative/financial pillar consistently scored low. The factors which contribute to low scores for this pillar indicate that more attention is required at the institutional level to: budget EGS production costs from the revolving fund; ensure timely planning for procurement; and maintain and use customer data bases to update seed requirements. During the peer visits, the findings are used to develop a set of strategies using a "Strengthens, Weaknesses, Opportunities, and Threats" (SWOT) analysis for NARIs to improve their weakest pillars and sustain their sweetpotato business in the long-run. The visits to another four NARIs will be completed (to make a total of seven of the twelve NARIs) by the end of 2018, with write up in early 2019.

Evaluating the effect of begomoviruses. As part of a field survey in Central Kenya, 100 samples were collected in October 2017. All regions that produce sweetpotato in Kenya have now been surveyed (i.e., Western, Nyanza, Coast, and Eastern) for begomovirus presence. A total of 896 samples have been collected and 167 tested by PCR to confirm begomoviruses. Two seasons of a field trial using virus tested and virus infected (with Begomovirus, SPFMV, and SPCSV, alone and in all possible dual combinations) for varieties 'Kakamega' and 'Ejumula' were completed and data are currently being analyzed.

Improve and validate diagnostic methods for support of seed quality, germplasm management, and exchange. Previously, three successive iterations toward a universal diagnostic sweetpotato virus tube-array, known as

[6] KEPHIS and INERA only produce & sell pre-basic; SARI, IIAM produce pre-basic which is then used to produce and sell basic seed. Other NARIs produce and sell pre-basic and basic.

ClonDiag, were developed, which were validated against samples from East and West Africa. A fourth iteration was designed with improved performance and included newly discovered viruses. The following viruses can now be detected: CMV, SPCSV, SPV2, SPFMV, SPVG, SPVZ, SPMMV, SPCV, SPVCV, SPC6V, SPPV, SPSMV, SPCFV, SPLV, SPLSV, SPMSV, SPCLV, IYVV, TMV, and TSV. To analyze the result from the arrays, a smartphone app was also developed and in 2017, this was finalized into a stable version and is functioning well. Parallel testing between Lima and KEPHIS, where Lima used the smartphone app developed for the data analysis and KEPHIS used both the smartphone app and the dedicated array reader was conducted and it was determined that the correlation between array results and indexing was 100% for infection status using 25 plants infected with different virus combinations (i.e. plants infected by at least one virus), but that if several viruses were infecting the same plant, the array did not necessarily detect all of them. An additional 200 assays are currently being performed on material that is going through (or has recently gone through) standard indexing including at least 50% healthy plants to assess false positive rate.

The second diagnostic method, LAMP is a rapid and sensitive virus diagnostic tool aimed for use in the field. Previously, LAMP assays were developed for eight sweetpotato viruses, but due to performance issues we decided to focus on the main viruses SPFMV, SPCSV, and begomoviruses. Primers for SPCSV and begomoviruses were redesigned to improve performance, but only the begomovirus one functioned well.

We have established that LAMP is equally sensitive and reproducible like RT-PCR in detection of SPFMV. Our attempts to optimize drying down procedures to obtain a LAMP test that was thermostable for longer periods, was not progressing as expected. Therefore, to achieve the target of a thermostabilized LAMP test for SPVD which is in a ready-to-use form and robust to interruptions of the cold chain we have now identified and ordered a commercially available dried down master mix, which is stable for a year at room temperature and which only requires the addition of water, primers and sample. Extensive field testing of this format will take place in July 2018.

Training. In a complementary project funded by BMGF "Next generation phytosanitation" high throughput sequencing is being further developed and validated as a rapid and generic virus indexing method for sweetpotato, cassava and yam. During two one-week courses, key staff involved in germplasm health testing from CRI and CIP Ghana, and KEPHIS, and CIP Kenya, were trained in the use of this technology including bio-informatics analysis. This approach is also being validated as an alternative to host range indexing and can therefore be an alternative for the ClonDiag array that has been developed under SASHA. Which one will finally be adopted will depend on the success of validations of both, together with logistical and cost considerations.

Fingerprinting all released and elite materials at SSPs to ensure correct identity and remove duplicates. The final selection for the best-bet variety characterization consists of 116 clones/varieties. These represent 16 African countries (Burkina Faso, Côte d'Ivoire, Ethiopia, Madagascar, Nigeria, Ghana, Rwanda, South Africa, Sierra Leone, Burundi, Kenya, Malawi, Mozambique, Tanzania, Uganda, and Zambia). In total, 111 samples have been collected. All varieties have undergone virus cleaning by meristem tip culture and thermotherapy at KEPHIS. These will be virus tested and indexed and conserved in-vitro tissue culture and in-vivo in screenhouses (double protection insect proof cages).

One hundred of these varieties have been sampled for genotyping by SSRs markers at BecA–ILRI Hub. These samples are being worked on by two students under the Africa Bioscience Challenge Fund (ABCF) for two different studies:

1. Characterization and genetic diversity of the 100 best-bet sweetpotato varieties: DNA samples were sent to Diversity Array Technology (DArT-http://www.diversityarrays.com/) for single nucleotide polymorphism (SNP) and DArTseq analysis.
2. SSR marker development from the ß-carotene genes pathway for marker-assisted selection.

Ninety-eight varieties of best-bets were planted at KALRO–Kiboko in April 2018 for phenotypic assessments. Data were collected at 90 DAP for 33 descriptors. Roots will be sent to CIP-Uganda for quality characterization using NIRS at 120 DAP. This information will be used to produce an online best- bets catalogue before the end of 2018.

(3) Objective 3.3 aims to further adapt quality declared planting material standards and inspection protocols in collaboration with national regulatory bodies. During this reporting period, the sweetpotato seed standards for Rwanda[7] and Mozambique[8] have been officially approved (or gazetted), adding to Ethiopia, Kenya (QDS not recognized) and Tanzania (formal seed classes only). All eleven countries have now drafted seed standards for sweetpotato (where none previously existed) or have revised existing seed standards (e.g. Malawi and Zambia). This has been done in consultation with key stakeholders and with support from different projects and organizations (e.g. HarvestPlus, University of Makerere, CIP). Delays in final approval (ratification or gazetting), relate to the status of principle Act governing seed regulations; national elections; and preference by the regulatory body to make a joint submission for ministerial approval with other crops. There is insufficient investment in capacity building for a countrywide roll-out of sweetpotato seed inspections, but there is limited implementation with support from different projects.

Collaboration continues with the International Food Policy Research Institute between CGIAR Research Programs (CRPs) RTB; Policies, Institutions, and Markets; and Forests, Trees, and Agroforestry, under the project "Making seed systems and markets for vegetatively propagated crops (VPCs) work for the poor" completed field work for seed potato (Kenya) and cassava (Nigeria and Vietnam). A write-up is in process to produce a synthesis paper that addresses the types of public policies, regulations, or regulatory reforms are in place and how they are implemented to provide access and availability of quality vegetatively propagated planting material.

(4) Objective 3.4: Test and document models for medium- to large-scale basic seed production ("The Missing Middle"). Activities continue in Ethiopia, Uganda, and Tanzania to test models for medium-scale basic seed enterprises to act as a link between upstream PBS and downstream decentralized multipliers. In Tanzania, the multiplication calendar was developed for basic seed production in the screen house and open nurseries. This provided the basis to determine the costs of production at TZS. 34 per cutting for mini-screenhouse production; compared to unit cost of open field multiplication of TZS. 16 per cutting (25-30 cm cuttings). This information will enable multipliers to better plan their activities and to understand their minimum sales price to run a profitable business. Responding to stakeholder pressure, the Tanzania Official Seed and Certification Institute (TOSCI) has scrapped the mandatory registration fee of TZS. 100,000 (about US$50) for all crops. This now makes it easier for sweetpotato vine multipliers to officially register as seed producers. A stakeholder meeting to develop joint marketing and promotional activities for pre-basic and basic seed was held at the Lake Zone Agricultural Research and Development Institute (LZARDI). These include: lobbying the local government administration to allocate funds and include OFSP in their nutrition programs; and strengthening linkages between root producers and various markets. This is expected to increase number of farmers using clean seed. The joint activities will enhance linkages between pre-basic seed producers and the "Missing-Middle" basic seed multipliers.

In northern Uganda, the East Acholi sweetpotato producers and vine multipliers' association reported $9,600 revenue on vine & root sales in year 4. The 13 seed and root entrepreneurs made a field visit to Peter Omondi's vine business in Gulu and undertook a refresher agronomy training in late 2017. Training in seed inspection was completed for 39 entrepreneurs, extension workers and District Agricultural Officers from Kitgum, Lamwo and Pader districts in March 2018. The business plan consultant followed up on the implementation of business plans. Nine of the 13 entrepreneurs need to make changes to their plans: including changes in acreage of the multiplication gardens, and hence, projected output for both vines and roots; and changes in selling price for both vines and roots, hence revenue projections. Market promotion activities including local FM radio talk shows and spot messages over June-July; and branded tents at local markets have been completed. Heavy rain in the 2018 season led to destruction of vine multiplication plots and difficult access to markets. Now that the seed and root entrepreneurs are seeing the benefits of vine multiplication they are requesting further training in business skills.

The studies to address technical questions relating to rotation practices and isolation distances are ongoing.

[7] Ref. 23. RSB/TC 032, Seeds and Planting Materials) on RS 275-5: 2017).

[8] Bolletim de Republica I serie Numero 112. 7/6/2018 Diploma Ministerial 50/2018

Sweetpotato-rice-sweetpotato rotation trial. Four cycles (three rotations) of the trial have been completed. The results for the third rotation show a significant difference in yield, harvest index (HI), and incidence of Alternaria blight between the control and the rotation crop ($p<0.05$). The yield in the rotation was significantly higher (average yield= 69 t/ha) than in the control (average yield= 35t/ha).

Combined analysis of the three rotations shows that average sweetpotato root yields in the rotation was significantly higher (average yield= 28 t/ha) than in the control (average yield= 19.8/ha). The higher yields in the rotation experiment could have been due to the residual fertilizers applied in rice the previous seasons. Vine yields were not significantly different across treatments and varieties but significantly different across seasons. This could be because of weather variations across seasons as 2016B experienced a prolonged drought compared to the rest of the seasons.

To monitor incidence of SPVD across seasons, the original clean planting material sourced from Biocrops were recycled over four seasons. The incidence of SPVD increased from season 1 to season 4. However, the highest incidence reported in season 4 was an average score of 3.7, which is still low. Generally, northern Uganda is considered a low SPVD zone, hence the low buildup of SPVD over a period of four seasons. When tested for presence of viruses, samples from the rice- rotation experiment tested positive for more than two viruses. Viruses identified include SPFMV, SPMMV, SPCFV, Sweet potato mild speckling virus (SPMSV), C-6 virus, SPCSV, Sweet potato virus G (SPVG) and Cucumber mosaic virus (CMV). This confirms the fact that there is build-up of viruses even in a low virus pressure area over time. This implies that planting material should be replaced with clean material after three seasons of recycling.

Results from the economic analysis show that there is a statistically significant difference in mean profit ratio between rotation and control. The comparison of net profit ratio by treatment and control shows that net profit ratio in the treatment was higher by 0.43 than in the control group. This is a significant and positive difference. The results also indicate that net profit significantly and positively increases when the number of rotations per season increase.

Test viability of (large-scale) basic sweetpotato seed production in isolated low virus pressure areas. The fourth cycle of planting was harvested in September 2017. Root yield was significantly different across farmers and varieties ($p<0.05$). 'Ejumula' variety had the highest yield (42 t/ha) compared with 'NASPOT 10' and 'NASPOT 11'. The incidence of SPVD and Alternaria blight did not differ significantly between farmers and varieties and remained low; at maximum score of 2 for SPVD and 1 for Alternaria blight. Similarly, weevil damage remained low across farmers and varieties. Data collection for this trial was completed in November 2017. Results from this trial will be compared with those from the experiment set up the high virus pressure area of Rakai/Kyotera. The data collection for the Rakai trial will be completed in September 2018, so the full analysis and draft of the manuscript will be completed in November 2018.

Testing use of different aphid-proof net structures in high virus pressure areas, Rakai, Uganda.

Objective 1: Assess number of cuttings (20-cm or 30 cm[9] long) produced under on-farm mini-screenhouse, net tunnels, and open fields (control). A second trial was designed to improve the traceability of planting material sourced from the different treatments through to on-farm evaluation of storage root yield. This trial was planted in April 2017 with planting material (Ejumula, Kabode and NASPOT 11) sourced from BioCrops tissue culture laboratory and continues up to September 2018 for storage root yield evaluation. Vine harvest data at the three different sites each with mini-screenhouse, net tunnels, and open field beds started at 60-75 DAP for the initial lot of harvesting and subsequent ratoons done at the interval of 60 days between successive lots. Results after the third successive harvesting of vines showed that net tunnels significantly ($p =\leq 0.005$) produced more cuttings than either mini-screenhouse or the control

[9] The size of cutting varies depending on whether it is to be used for further multiplication or for root production. Harvesting of 20-cm long cuttings was done initially at 75 days after planting and subsequently every 60 days between successive lots of harvesting. Harvested vines were planted at the spacing of 0.2m by 0.2m for bulk multiplication in the open field beds for about 60 days before it was sold to other farmers for production of storage roots using mounds of 1m^2 each planted with 3 cuttings of 30-cm long each. Prior to harvesting, samples of 30-cm long each cuttings were sampled for the number of nodes per cutting.

open-field bed. But in all treatments the planting material was still vigorous. This confirms results from previous 2016 trial. Kabode produced more nodes per 30 cm cutting irrespective of mode of multiplication and cycle; more nodes per 30-cm long cutting were produced from the second on-farm cycle compared to the first on-farm cycle.

Objective 2: Validate the biomass yield of successive seasons of recycling on farmers' fields. Two additional on-farm trials for storage root yield evaluation (using normal planting season) were planted in September and November 2017 using materials originally sourced from the treatments planted in April 2017. Data on storage root yield (t/Ha) showed that miniscreen house-sourced planting material yielded significantly more storage roots than either net tunnels or open fields.

Objective 3: Assess the financial cost benefits of using net tunnels and mini-screenhouses as options for protected beds for conservation and multiplication of sweetpotato planting material. Data collection on financial cost of the two options for net protection was also reviewed and initial data analysis completed. To measure complete benefit, it is necessary to measure the benefits generated across the seed value chain through when planting materials reach the root producers. This data collection continues up to September 2018 to capture complete financial cost benefit of the different treatments on storage root yields.

Develop protocols and conduct field work to assess how incidence of SPVD in Tanzania is affected by isolation distance. This study seeks to assess the effect of different isolation distances in limiting the spread of SPVD in two areas where sweetpotato is intensively cultivated. Three isolation distances between sweetpotato plots—5, 10, and 15 m—are compared. The first round of experimental plots at three different sites were established in March 2017. Data from this round are archived awaiting analysis of leaf samples for virus infection. The second round of experiments was established in November 2017. One variety (Mataya) was planted. Harvesting and leaf sampling was done in April 2018 and virus-testing of leaf samples is ongoing at BecA-ILRI laboratories, Nairobi.

Financial feasibility of sweetpotato vine multiplication in Uganda and Tanzania and implications for going-to-scale. Most sweetpotato dissemination efforts have invested in establishing networks of farmers trained to be vine multipliers with the goal of assuring timely access of growers to quality planting material. Understanding which of the different models are most profitable to the farmers is key to understanding the likelihood of seed availability being sustained after a project ends. A field study was conducted from December 2017 through February 2018 Uganda and Tanzania to identify financially viable vine multiplication models for adoption. The results were subsequently used to determine the number of vine multipliers needed to adequately supply clean sweetpotato planting material nationwide in the two countries. To address these objectives, the study used the transaction cost theory and cost benefit analysis. Since the ability to maintain quality seed over seasons is heavily influenced by the degree of sweet potato virus disease (SPVD) pressure, a case study approach was used to identify and select vine multipliers in different SPVD pressure areas and in different agro-ecological zones. The study purposively selected 15 vine multipliers from Uganda and 30 from Tanzania. In addition, key informant interviews (KII) were conducted with other stakeholders involved in sweetpotato seed value chain.

The findings from the study indicate that increasing transaction costs for basic multipliers due to long distance to the pre-basic seed sources, inadequate experience in using protected structures in basic seed multiplication, difficulty to maintain basic seed during the dry seasons, low market demand for quality planting materials and limited varieties available for multiplication constrain the availability of quality planting material to vine multipliers and subsequently root farmers. The study found that there was lower transaction costs and better management of vines in larger protected structures (mini-screen houses) than the small protected structures (net tunnels).

Two major vine multiplication methods exist in Tanzania and Uganda, namely, conventional and rapid multiplication methods. In the conventional method, farmers use plant spacing suitable for root production (i.e. 30 by 90-100 cm) and produce vines concurrently, whereas in rapid multiplication, farmers employ high density planting (for example, 10 X 20 cm) with the aim of harvesting vines only. In this study, both the rapid and conventional method of vine multiplication could be financially viable. But in many cases, the crop management in the conventional approach compromised significantly compromised the quality of the seed and roots, decreasing the probability of long-term viability. If recommended agronomic practices were considered, rapid vine multiplication was financially feasible, but the conventional vine multiplication was not. The study found that multiplication of vines without using protected structures is more financially sound than when vine multipliers used the protected structures (note, however, presence of virus in the material was not determined). Generally, multiplication of vines in the low SPVD pressure areas is more profitable than in the high SPVD pressure areas. This is driven by higher vine demand in low SPVD pressure areas due to high drought pressure, compared to the moister high SPVD pressure areas.

Scenarios developed based on the most financially feasible method of vine multiplication (rapid multiplication with protected structures) indicate that the minimum price of a bag of vines having 1000 cuttings should be at least USD 3.5, and the multiplier needs to sell at least 2,000 bags of vines per hectare. Conventional vine multiplication can be profitable some vines are multiplied rapidly in a smaller plot (for example, 0.1 hectare), with some of the vines from this plot sold and the rest used in a conventional multiplication plot. Thus, so-called conservation plots should be encouraged among the conventional vine multipliers.

To adequately meet national demand in each country, the study recommends the establishment of 115 vine multipliers in Uganda and 184 vine multipliers in Tanzania, each with at least 0.4 ha committed for rapid vine multiplication each year to ensure adequate supply. The study recognizes that subsidies will be required to support establishment of protected structures in high SPVD areas, to avoid risks of complete loss of vines because of SPVD. The proposed maximum distance between the vine multipliers in the major sweetpotato growing districts regions should not be more than 200 km in low SPVD areas and 100 km in high SPVD areas.

D. RP4: Postharvest and Nutritional Quality (details provided in Appendix E)

This is a diverse research program, jointly led by NRI and CIP to address postharvest bottlenecks that are slowing down value chain development. Three of the six milestones are behind schedule by a few months; two are almost achieved, and one is on track (Appendix A). The first three objectives were to be completed in 3 years but will now take 4.5 years to finalize; the last in 5 years.

(1) Objective 4.1: To develop cost-effective technologies to enable commercially oriented farmer organizations to supply quality sweetpotato roots year-round to specific agro-processors or urban markets. The key output is to develop cost-effective technologies that do not require access to the national electricity grid to cure and then store fresh OFSP roots at medium to large scale for a minimum of 4 months. In Kenya, the appropriate storage facility is linked to a puree processor. Storage for 1–4 months is needed to smooth supply. The initial 2.5-year effort focused on the construction and testing of a 9-t storage facility based on evaporative cooling (Milestone report OBJ4MS1.B. submitted earlier describes findings in detail). The facility could not get below 20°C for significant periods of time. Hence, a decision was made to test another approach. The unit was constructed by NRI engineer Marcelo Precoppe in June 2017. The environmentally controlled sweetpotato storage unit was designed to cure 5 t of roots at 28°C and relative humidity (RH) of >85%, followed by storage at 15°C and RH >85%. The system was built using a 6-m intermodal dry freight container and was designed to be affordable, durable, and easy to operate. The entire system is powered by solar energy using a rooftop photovoltaic system.

A storage trial (the fifth in this effort) with 5 t of roots was initiated on 3 October 2017. In previous trials it was found that store heating was necessary to bring the temperature up to 28°–32°C for curing. For this reason, the store controls during the curing phase were set to heat but not to cool. However, the roots used in this trial had a higher metabolic rate than previously experienced (indicating that they were stressed), so that during curing the temperature rose above 32°C for 32 hours and even reached as high as 34°C. This compromised the quality of the roots such that despite the lower temperatures, the root quality was not improved relative to earlier trials. In some cases, it was worse.

In preparation for storage trial #6 planned for February 2018, using the same facility, two smaller trials were conducted at NRI in the UK:

- **Reevaluation of optimum curing conditions.** In the UK, efficiency of wound-healing at a range of temperatures (15°, 24°, 28°, and 32°C) was followed by staining for the lignification, using staining with phloroglucinol. For both consignments very little wound-healing was seen at 15°C, maximum wound-healing efficiency was observed at 28°C, and for one consignment there was a clear reduction in efficiency at the higher temperature of 32°C. This trial confirmed the need for higher temperatures during curing. But based on these results, the recommended curing temperature is 28°C.

- **Store testing to ensure homogeneity of storage temperature and RH.** Given the sensitivity of roots to overheating during the curing phase the temperature and humidity were carefully mapped across the store in Kenya to check for any hot or cool spots, so that adjustments can be made to the airflow to reduce these. This trial involved loading the store with roots and the placement of 20 temperature humidity dataloggers throughout the store. The profile of temperature and humidity was tested, and then the airflow adjusted by the placement of appropriate baffles to improve homogeneity. Figure 1 shows the profile for temperature and relative humidity within the store following optimization (Further information is given in Appendix E). On the left is the air temperature, which shows that even the maximum temperature reached at the bottom of the facility (in red) does not exceed 15.1ºC. On the right, the relative humidity throughout the store is always above 86%, and in the majority of the space between 89 & 93%. These are excellent conditions.

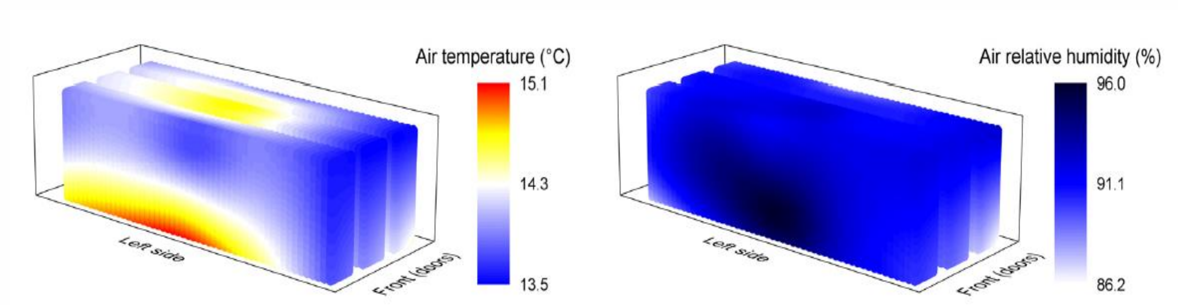


Figure 1. Temperature and humidity distribution during storage after installation of air deflectors.

The next storage trial was initiated in February 2018. In addition to testing the store, treatments were included to test the effect of pre-storage washing and to determine the potential to improve storage quality through preharvest removal of the canopy (dehaulming), a treatment previously shown to toughen the root skin. Assessments were carried out each month to determine quality parameters, the percentage of root material suitable for puree production and the quality of puree produced.

For the trial set up OFSP were harvested from 9 different and spread-out smallholder farms. Approximately 3.5 tons of the OFSP were of storage quality (i.e. not weevilled, not broken, not too small). Dehaulming happened on half of each field 4 days before harvest. Baseline sampling of fresh roots and puree quality were conducted.

The main findings are summarized in Figures 2 and 3. Although the store was able to maintain temperature and humidity within the target range, the rate of weight loss and the level of overall losses were greater than expected. Table 1, indicates that the percent of root material suitable for processing after 4 months was less than for the trials carried out using the evaporative cooling store for which the storage temperature was higher (20 - 22°C). An investigation revealed that the CO_2 concentration in the store was greater than 1% through the 4-month storage period. This would have stressed the roots considerably, leading to high losses due to rots. The conclusion is that we should monitor CO_2 and ensure increased ventilation through the whole storage period.

Table 1: A comparison of losses for the two solar-powered trials using different technologies

Storage Type	Evaporative cooling 20 - 25°C	Refrigeration 15°C
Variety and Initial Condition	% root tissue for processing relative to initial fresh weight	
Kabode Unwashed	60	45
Vita Unwashed	81	
Unwashed dehaulmed		56
Kabode washed	67	35
Vita washed	80	
Washed dehaulmed		45

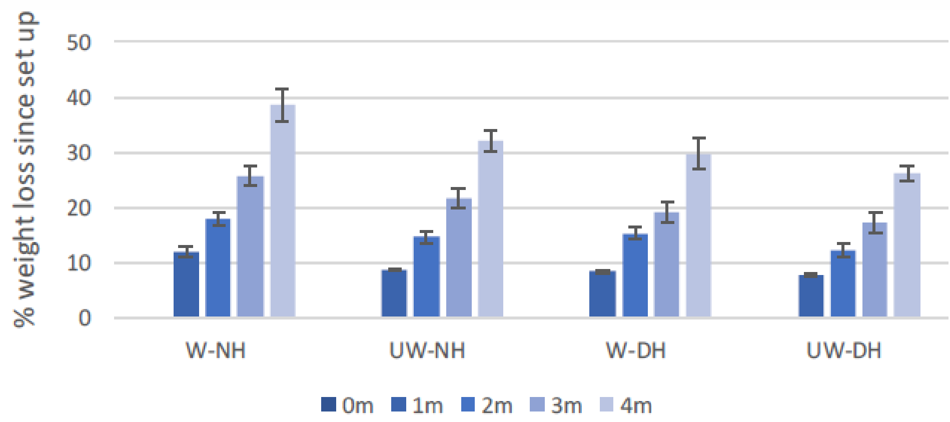


Figure 2: % weight loss of fresh roots at monthly intervals during storage. Each data point is the mean +/- standard error for 4 boxes of roots. W, UW indicates washed or unwashed before storage. NH, DH indicates haulm left, or removed 4 days prior to harvest

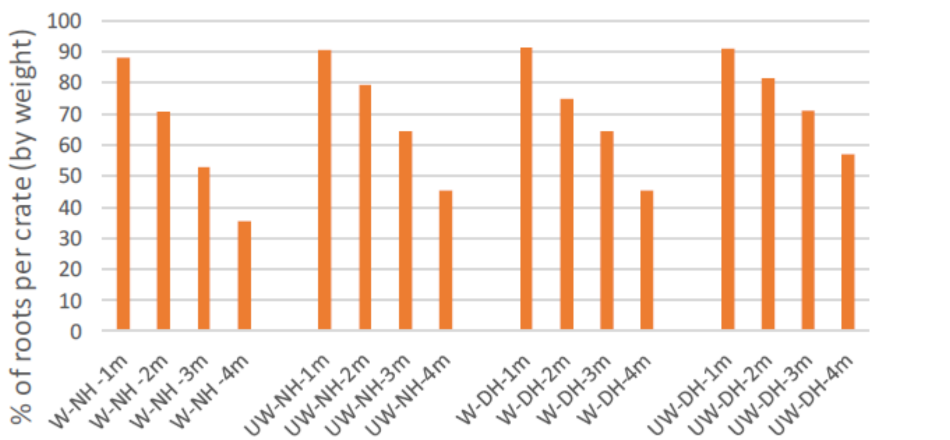


Figure 3: Percent weight of fresh roots that could be used for processing to puree relative to initial fresh weight of roots. Categories same as those in Figure above.

Returns to Solar-Powered vs Electrical Power Storage. A report has been produced to analyze strategies for medium/large scale OFSP storage that are economically and technically feasible for selected locations in SSA. The report includes an analysis of the efficiency and cost of the two store types constructed during SASHA (based on evaporative cooling and standard refrigeration respectively), a description of the store designs, and an economic analysis of the benefits of storage.

As expected, the initial findings indicate that the storage costs significantly increase the cost of stored roots (approximately 3-3.5 times), so that storage will only be a useful strategy if this compares favorably with the supply of roots out of the main season. The break-even prices shown in Table 2 are very high for either method, making purée uneconomic as a wheat flour substitute. Strategies to reduce this additional cost are currently being investigated. For example, one option is to use a photovoltaic system without energy storage in batteries, so that power is only provided when the sun is shining (Option 3 in Table 2). In this case a backup generator could be available for emergencies. Reducing the loss rate during storage is critical for making fresh root storage cost-effective. If that cannot be achieved, an alternative is to explore storing for up to two months, converting roots into purée as quickly as possible and storing the purée.

Table 2. Comparison of Storage Costs using Solar-Powered Evaporative Cooling (Option 1) versus Solar-Powered Air-Conditioned Cooling (Option 2) versus a Solar-Powered Air-Conditioned Cooling system with No Battery Storage (i.e. Reliance on the Electrical System during the night, Option 3).

SASHA Project, Sweet Potato (SP) Storage Costs

Storage period: 4 months, different options considered regarding investments, energy sources, and losses.
Break-even price corresponds to the price of sweet potatoes at the beginning of storage (high season), taking total storage costs and losses into account.
This needs to be compared to the price of sweet potatoes at which processors can procure them during the low season, either from the market, or through their own production.

Summary of options (in USD)	Option 1: Evaporative cooling		Option 2: Air-conditioner cooling		Option 3: AC cooling
	Photovoltaics	National grid	Photovoltaics	National grid	Photovoltaics, DC
Purchase price of SP, per t of SP (before storage)	140.00	140.00	140.00	140.00	140.00
Total fixed costs, annualised capital costs (ACC), (per t for 4-mth period)	103.75	68.17	144.11	72.95	97.65
Total maintenance costs (MC), (per t for 4-mth period)	34.83	18.17	47.17	13.83	8.48
Total operational costs (OC), (per t for 4-mth period)	21.80	59.60	21.00	131.20	21.00
Opportunity costs of stored SP (@ 13% interest rate p.a.) (per t for 4-mth period)	6.07	6.07	6.07	6.07	6.07
Total storage costs (ACC, MC, OC, Opp Costs) (per t for 4-mth period)	166.45	152.01	218.34	224.05	133.20
Losses (SP to be discarded after 4 months of storage, due to root spoilage etc)	25%	30%	25%	25%	25%
Tonnes of SP needed to obtain one t of SP for processing (after 4 months storage)	1.33	1.43	1.33	1.33	1.33
Total storage costs (ACC, MC, OC, Opp Costs) (for this amount of SP for 4-mth period	221.93	217.15	291.12	298.74	177.60
Break-even price per tonne of stored SP ready for processing mash	408.60	417.15	477.79	485.41	364.26

Storage facility in Mozambique. Late in 2016, together with SUSTAIN in Mozambique, SASHA developed a partnership with EcoTech Hydro & EcoTech Energy, a small engineering firm based in Knysna, South Africa, which has ample experience in solar power and water engineering. In December 2016, the firm tested using a CoolBot, which is a device readily available on the market for about $400 that forces a conventional air-conditioner to lower its temperature. The unit was constructed. Jan Low visited EcoTech in October 2017 and suggested further improvements; a modified contract was prepared and signed. It took some time for the unit to be completed and then transfer and shipping to Mozambique had to be arranged. This unit only arrived at the site in Marrucuene (one hour outside of Maputo) on the 20th June 2018. A technician for Ecotech will spend a week setting up and testing the facility in July 2018. The unit is hosted at a farmer's cooperative and a student will conduct a storage trial, comparing using the solar-powered air-conditioned unit to pit storage beginning in August 2018.

(2) Objective 4.2: To ensure year-round supply of OFSP in nutritionally at-risk households, develop convenient and low-cost methods for fresh root storage. At the household level, storage in sand (Double S) has clearly emerged as the best option for storing sweetpotato roots. In areas with long dry seasons, storage up to 6.5 months is possible in stepped pits, and up to 4.5 months in sandboxes. Both approaches use dry, cooled sand as the substrate between root layers. Erna Abidin was lead author on a ten-page brochure launched at the annual Marketing, Processing and Utilization Community of Practice meeting in April 2018, entitled *A Guide to Storage of Fresh Sweetpotato in Sand Pits or Boxes: Extending Fresh Sweetpotato Root Availability in Drought-Prone Areas after Harvest.*

Research work on handling of sweetpotato roots continued in 2018, with a study initiated in June 2018 to explore the impact of visually differentiated packaging (e.g. orange crates and orange net bags with labels) on OFSP sales and customer engagement and demand in informal and formal markets of Nairobi. The specific aims are:

- to better understand consumer behavior surrounding fresh sweetpotato root sales in a range of Nairobi markets, including their awareness of and interest in OFSP roots
- to better understand the role of packaging (orange colored crates and/or orange net bags) on consumer interest and purchase behavior regards OFSP roots in Nairobi markets.

A reconnaissance phase in late May/early June explored sweetpotato marketing in seven informal markets (City Park, Kangemi, Kawangware, Wangige, Ngara, Muthurwa, Marikiti) and three high-end grocery chains in Nairobi. The reconnaissance study updated and reconfirmed the 2014 value chain study's findings that, in Nairobi's informal markets:

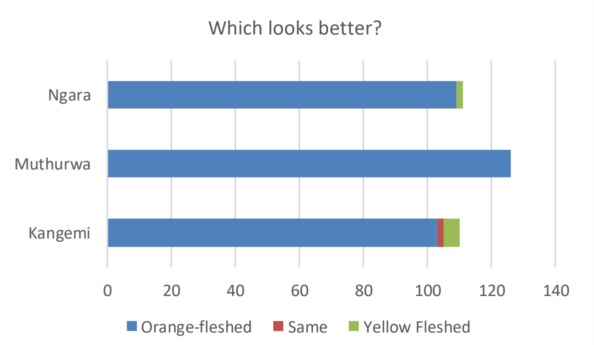
- the sweetpotato sold is grown mainly in western parts of Kenya and Sirare in Tanzania
- all the sweetpotato sold are yellow-fleshed sweetpotato (YFSP) varieties with a red skin, roots are washed after harvest, then packed and transported by truck to Nairobi; this is in response to customer demand
- most traders are not aware of OFSP and have no customer demand for OFSP and therefore do not sell it

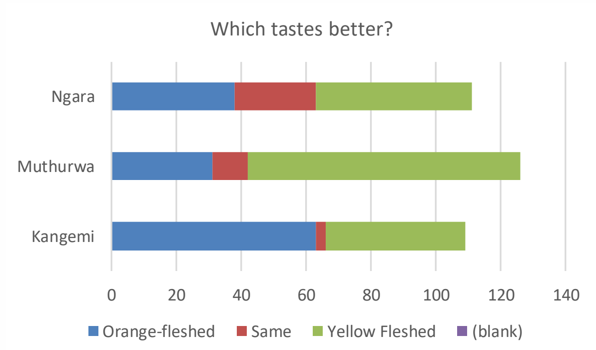
- the sweetpotato roots were typically sold in piles or bowls of different sizes marked with a price sign of Ksh 30 or 50, only in City Park market were traders selling by the kg
- sales price of sweetpotato roots ranged from Ksh27 to Ksh80 per kg; and was higher in City Park and Ngara (Ksh65-80/kg), than in the other informal markets visited (Ksh20-30/kg)

In the high-end grocery chain stores visited, the owners were aware of OFSP and reported customer demand for it and stated that they sold out of it quickly whenever they received consignments of it. The OFSP they received and sold was white skinned with orange-flesh. They were all keen to receive a lot more OFSP and on a more regular basis. They sold OFSP at Ksh 150-169/kg.

These findings shaped the main study, which selected 3 informal markets (Kangemi, Muthurwa and Ngara) and 3 high-end groceries (Corner Shop, Field Fresh, Zucchini) in Nairobi to study customers sweetpotato shopping and eating habits. This was done through a survey which included offering customers both OFSP and YFSP cooked roots to visually inspect and to taste, and an exploration of their existing and desired knowledge surrounding OFSP.

The preliminary analysis of the data from the informal markets (347 respondents) highlighted Kenyan consumers: tendency to purchase fresh sweetpotato roots 1-3 times per week; spending Ksh50 per purchase; preference for YFSP fresh roots; eating them for breakfast. When asked to taste and compare boiled OFSP and YFSP roots – they overwhelmingly (>90%) reported preferring the OFSP, but with regards to taste the results were more mixed with 51% preferring YFSP than OFSP (see figures below).





Prior to our survey, 88% of the 347 respondents in the informal market had never heard of OFSP before, highlighting the lack of awareness that exists in urban centers regards this nutritionally-rich locally produced food source. Respondents wanted to know about the nutritional value of OFSP, how to cook it, where to get vines for it, how to grow it, which agro-climatic conditions it prefers, how long the roots take to mature, where they could buy and sell the roots, and where our sample roots had been grown. The study will be completed in August 2018.

CIP's food scientist Tawanda Muzhingi and his team produced the following study for this objective: *Proximate composition of long-term storage of orange-fleshed sweetpotato (OFSP) roots.* There was no significant (p>0.05) changes in protein and fat content of the roots over the 4-month storage period in Western Kenya; however, there were noticeable changes in moisture and carbohydrate content. The crude ash and crude fiber content of OFSP roots varied between 0.8–1.5 g/100 g and 1.0–1.5g/100 g (fwb), respectively.

(3) Objective 4.3: To develop appropriate production and storage methods for quality sweetpotato puree and ensure that products made from stored puree are safe and nutritious. The goal is to be able to store quality puree for 4–6 months without a cold chain, and to ensure that the products made from stored puree are not markedly different from those from fresh puree. The team and students associated with it continue to conduct experiments related to puree utilization. During this reporting period, results from three sets of experiments were prepared (see Appendix F for details).

A brief description of experiments conducted, and key results obtained in this period are described below:

1. Nutrient Composition of OFSP breads. OFSP breads were prepared by substituting wheat flour with 0%, 20%, 30%, 40%, and 50% OFSP puree. Proximate composition results ranged from 28.6–32.7% moisture, 3.5–3.8% fat, 6.7–7.6% protein, 1.2–1.4% fiber, 1.7–2.2% ash, and 53.2–56.9% carbohydrate. β-carotene content significantly

($p<0.05$) increased with an increase in proportion of OFSP puree. Consumption of 100 g of bread formulated with 50% OFSP puree can provide good amounts of vitamin A to young children and pregnant women.

2. Beta-carotene content of OFSP bread make with shelf-storable OFSP puree. The use of shelf-storable OFSP puree as an alternative to fresh puree in bread production was evaluated in terms of its impact on the physico-chemical attributes of the bread. There were two levels of preservation treatment: (1) puree with 0.5% potassium sorbate, 0.5% sodium benzoate, and 1% citric acid, and (2) puree with 0.2% potassium sorbate and 0.2% sodium benzoate. OFSP puree stored for up to 4 months were used to substitute wheat flour by 30% and 40%. Bread using freshly made OFSP puree served as the control. A 40% shelf-storable OFSP puree-based bread for both treatments had lower crude protein and carbohydrate content and higher ash content than the white bread (control). A 3-month-old shelf-storable puree provided up to 58.03 ±3.90 µg RAE 100/g—significantly higher than the levels in white bread.

3. Consumer Acceptability of OFSP Bread made from shelf-storable OFSP puree. Bread from shelf-storable OFSP puree with similar sensory qualities to bread developed from fresh OFSP puree. The study found that all the bread samples, at two levels of preservatives and two levels of wheat flour substitution (30% and 40%), were acceptable to consumers as they had overall acceptability rating of above 5 (out of 9 maximum).

(4) Objective 4.4: To develop the regional capacity and appropriate protocols for analysis of roots and derived products at reasonable cost to ensure that they have adequate nutritional quality and meet safety standards. The key outcome is the establishment (achieved in early 2015) and use of FANEL, based at the BecA–ILRI Hub, a joint effort by BecA and CIP. The lab is led by Tawanda Muzhingi, a CIP food scientist, and until June 2018 supported by two CIP technicians, one of whom is financed under SASHA2 to carry out biochemical analysis and assist in lab management. As of June 2018, there is now one technician supported by SASHA2 responsible for coordinating the biochemical analysis. In addition to analytical chemistry, FANEL has capacity for food microbiology analysis because food safety concerns are a growing focus in Africa, and a strong food science capability would also support the work. FANEL has acquired state-of-the-art equipment for proximate analysis to conduct food composition analysis of OFSP roots and food products derived from OFSP. This year, an Inductively coupled plasma (ICP) capable of accurate mineral analysis, as well as potential contaminates, was shipped from CIP-HQ to FANEL and should be ready for use by September 2018. FANEL tracks the number of samples processed and charging outside clients such as HarvestPlus and Bioversity for services. During year 4, FANEL conducted 1,782 ß-carotene analyses; 729 vitamin C analyses; 582 proximate analyses; and only 30 yeast and mold assessments (see Appendix E for details).

Under the SPHI framework, a key goal is to ensure that OFSP-processed products have sufficient ß-carotene content to be considered good sources of vitamin A. During this period, OFSP products (baked and fried) from Malawi were evaluated at FANEL. The proximate composition results indicated that moisture content ranged from 0.8% to 65.3%; crude fat 0.3–26.6%, crude protein 1.6–8.0%, crude fiber 1.1–1.7%, crude ash 1.2–2.7%, and carbohydrate 29.8–65.1%. The total RAE for vitamin A for OFSP crisps, OFSP bread, variety 'Ana akwanire', variety 'Kaphulira', and OFSP buns was 558, 225, 1,017, 562, and 42 µg/100 g, respectively. Serving 100 g of OFSP crisps and boiled OFSP roots provides sufficient vitamin A body requirements in children aged 1–3 years and school-age children (aged 4–8 years). Results from analyzing products from Rwanda are presented in Appendix E.

Three master students (Cecilia Wanjuu, Joyce Musyoka, and Derick Malavi) in the Food Safety and Quality Management at University of Nairobi and who had worked on various OFSP-related projects in FANEL graduated in 2017. Malavi has published 2 articles based on his work, Wanjuu one, and Musyoka one. Details of their work are provided in Appendix E. Mr. Joshua Ombaka has under review a paper on "Consumer acceptance and sensory evaluation of OFSP puree breads made with fresh puree and made with 3-6-month-old shelf-stable OFSP puree".

FANEL hosted Dr. George Okoo Abong, Senior Lecturer, Food Science Department, University of Nairobi for his Africa Bioscience Challenge Fund Fellowship on the bioactive components in sweetpotato leaves and roots including OFSP, and in vitro glycemic index for OFSP processed products. He completed his fellowship and has submitted an article entitled ***Phytochemicals in Leaves and Roots of Selected Kenyan Orange Fleshed Sweetpotato (OFSP) Varieties*** to the journal Plant Foods for Human Nutrition and is awaiting response. This study reports for the first-time the inherent phytochemicals in leaves and roots of seven bio-fortified OFSP and two traditional white and yellow fleshed sweetpotato varieties from Kenya. Results indicate that vitamin C varied significantly ($P<0.05$) among the sweetpotato varieties regardless of the plant part, leaves having significantly ($P<0.05$) higher vitamin C levels than the roots. Total flavonoids and total phenolic compounds differed significantly ($P<0.05$) among varieties and within the plant -- being higher in leaves than roots.

Work was undertaken at FANEL to identify and quantify different carotenoids in products made with OFSP flour vs. OFSP puree. All-trans β-carotene was the predominant pro-vitamin A carotenoid in all the samples, whereas β-cryptoxanthin and 9 cis β-carotene were the least. Although not statistically different ($p>0.05$), root of the variety 'Vita' had the highest total β-carotene (21.75 mg/100 g DW) compared with that of 'Kabode' (21.18 mg/100 g DW). Processing of sweetpotato roots into puree enhanced total β-carotene content in 'Vita' puree (25.2 mg/100 g DW) and in 'Kabode' puree (22.2 mg/100 g DW). On the contrary, processing of roots into flour resulted in total β-carotene loss of about 32.19% in 'Vita' flour (17.21 mg/100 g DW) and 37.89% in 'Kabode' flour (15.36 mg/100 g DW). The carotenoid loss of OFSP flour is mainly due to photo-oxidation during solar drying of the chips. However, products made from OFSP flour had more carotenoid content than those made with OFSP puree. Perhaps the dehydration of flour increased the concentration of carotenoids in flour, hence not easily diluted with addition of non-OFSP flour. In contrast, OFSP puree had high moisture content, which contributed to dilution of total carotenoids when mixed with non-OFSP flour.

Progress has been made in assessing the bioaccessibility of carotenoids in OFSP supplemented products by doctoral candidate Sarah Chilungo. Digestive stability (DS) represents the percentage of carotenoids in food recovered in the digesta following digestion. On the other hand, micellarization efficiency (ME) represents percentage of carotenoids transferred from the digesta to the filtered aqueous fraction and signifies the amount of carotene available for body absorption. Between porridge and *chapati*, the amount of all-trans β-carotene in digesta ranged from 2.94 µg/g to 21.21 µg/g, which corresponded to 20.4% to 56.5% digestive stability. Overall, *chapati* had highest digestive stability ($p<0.001$). A similar trend was observed in the ME of the products: the ME of the *chapati* was significantly higher ($p<0.001$) than that of porridge, driven by the presence of fat in the *chapati* product. Products with OFSP flour registered higher DS and ME than products made from OFSP puree. In a related study, addition of oil in OFSP-supplemented products was critical to ensure greater carotene bioaccessibility. Using long-chain unsaturated oils, like sunflower oil, leads to greater carotene bioaccessibility than margarine and beef fat. (Results are presented in detail in Annex E4.1)

The effect of packaging material and storage condition on carotenoid content of OFSP flour made from the varieties 'Vita' and 'Kabode' was investigated. A total of 100 g of flour was packed in Kraft, HDPE, and AFL paper and stored under light:dark conditions to study the effect of packaging material on carotenoid degradation over a 4-month storage period. The study found that AFL is a suitable packaging material for OFSP flour. It is also clear from the study that light and oxygen are critical factors in the storage of OFSP flour. Where dark storage of OFSP is not possible, it is important to pack flour in AFL because it is opaque and thus prevents photo-oxidation. Packing of flour in AFL should be accompanied by vacuum-sealing for high carotenoid retention.

From 4 to 8 December 2017, FANEL hosted a regional workshop on *OFSP Food processing and Food Safety* with NRI and BecA to enhance the quality of OFSP products in SSA. Twenty-seven participants (15 men, 12 women) from 11 countries attended. The objective was to enhance compliance with food safety regulations by small-scale enterprises involved in RTB processing in SSA. The report of the workshop is found in Milestone Report OBJ4MS4.1.E.

E. RP5: Support Platforms, Knowledge Management, and Governance (see Appendix F)

In SASHA2, the SSP concept has been adjusted to meet the demands of its users. To support the achievement of the SPHI vision, CIP is working with national sweetpotato program partners, development actors, and other sweetpotato stakeholders to establish an Africa-wide network of technical support. The Regional Technical SSP, established during SASHA1, is composed of three sub regional breeding platforms hosted by national programs— Mozambique (IIAM), Ghana (CRI), and Uganda (NaCRRI). These host institutes have NIRS analytic capabilities. The sub regional facilities are linked to KEPHIS, which is responsible for sweetpotato germplasm clean-up and distribution within the entire region and, under SASHA2, training technicians. In addition, BecA now has the support function of sweetpotato genomics, transgenics, nutritional composition, and microbial analysis. The sub regional SSPs provide parent material to the national sweetpotato programs for further varietal selection and evaluation and technical backstopping from three CIP breeders in the region, each supported by a post-doc as a part of CIP's succession strategy. Because of the additional supplementary funding, there are now two meetings (not one) annually of the Seed Systems and Crop Management group, and an annual meeting for the other three CoP domains: (1) marketing, processing, and utilization (MPU); (2) measurement, learning, and evaluation (MLE); and (3) breeding and genomics, with the genomics component supported by the Genomic Tools for Sweetpotato project, led by North Carolina State University (NCSU).

All four milestones are on track for this research program (Appendix A). The vision of success for RP5 is a vibrant and growing sweetpotato CoP, in which knowledge advances are shared through virtual media and meetings, field visits, trainings, and services for key functions of germplasm exchange, virus diagnostics, and comprehensive training on sweetpotato. Key activities achieved during year 4 are discussed below.

(1) Hold annual SPHI meetings that bring SASHA2 and non-SASHA sweetpotato projects together for information exchange and review. The 8th Annual SPHI Technical Meeting took place on 24–26 September 2017, in Dar es Salaam, Tanzania, and had as its theme **"Building Resilient Food Systems with Sweetpotato."** The meeting incorporated a half-day exhibition held at Mlimani City Mall—a popular shopping mall in Dar es Salaam— on the 24th. During the exhibition, sweetpotato innovations from Tanzania, Kenya, Uganda, Malawi, Rwanda, Ghana, and Mozambique were displayed by CIP and partners as well as private sector entrepreneurs, reaching 537 people with successful OFSP-based food products. From the 25th through the 26th, researchers, donors, policymakers, private sector actors, farmers, and nongovernmental organizations working along various sweetpotato value chains in 16 countries in SSA engaged in technical discussions along the meeting theme at Ramada Resort. A total of 105 participants (64 men, 41 women) representing 42 distinct organizations were drawn from 16 countries in SSA and from Germany, Peru, the United States, and Britain. Selected participants took part in field visits (27–28 September) to see first-hand ongoing sweetpotato work by CIP, Farm Concern International, Sokoine University Graduate Entrepreneurs Cooperative in the Morogoro area, and SRI–Kibaha and AVCO Investments in the environs of Dar-es-Salaam. A full description of the meeting and events is provided in Milestone Report OBJ5MS1.2.H.

In preparation for the meeting, 17 SASHA update briefs and 29 non-SASHA project update briefs were prepared (compared with 39 briefs the previous year). In addition, we launched the OFSP Passport to Good Health. This 39-page booklet is the size of a passport and contains key facts and figures about OFSP as well as contact information about where to get access to varieties and organizations belonging to the SPHI Steering Committee. It has proved to be very popular and is already in its third edition. In addition, the updated brochure on net tunnels was launched, now with three different options on how to build them. All briefs, the net tunnel brochure, and the OFSP passport are available on the SKP.

The SPHI Steering Committee (SSC) met for 4 hours on the afternoon of 26th September, with 14 out of 17 member organizations represented. Minutes of the meeting, chaired by the representative of the Director for Corporate Partnerships and Communication for the Forum for Agricultural Research in Africa (FARA), Aggrey Agumya, are presented in Milestone Report 2SSOBJ5MS1.2.J. Progress specifically on SASHA2 was reviewed by the project's PAC (Milestone report OBJ5MS1.2.I) during a half-day meeting on 27 September 2017.

This was the first year that the Excellence in Sweetpotato Awards were presented after an endowed fund was established by Jan Low at CIP using proceeds from her portion of the World Food Prize. Twenty papers were submitted for consideration to a committee chaired by CIP's Director of Research, Hugo Campos, to select the best sweetpotato scientific paper in 2016. Sweetpotato breeder Ernest Baafi won the $500 Best Scientific Paper in 2016 award for his paper entitled, "Exploitation of genetic potential of sweetpotato for end-user traits improvement." Tom van Mourik of Helen Keller International (HKI) regional office and Strengthening Partnerships, Results and Innovations in Nutrition Globally (SPRING)—Senegal, Albert Yéra Boubane—SBCC advisor at SPRING-Senegal, Mariam Sy—nutrition advisor at SPRING–Senegal, and Aliou Baboux—agriculture advisor at SPRING–Senegal put together a video on the advantages of OFSP that won this year's $500 Communication for Change Award. This community video encourages men and women farmers to try out and adopt OFSP for improved nutrition and food security; it is available in French and English.

(2) Hold technical CoP meetings at the regional level. All CoP meetings are held between January and July annually. The one exception is the Seed System CoP meeting, which targets the subgroup of participants who are subgrantees on the component of building sustainable EGS. The SS-CoP Eighth Consultation was held on 21–22 November 2017 at the Pride Inn in Nairobi, Kenya (Milestone Report OBJ5MS1.3M). The planning and review meeting was attended by the SASHA project PBS system subgrantees. There were 23 participants (11 women) from 11 countries. The participants were predominantly sweetpotato breeders and seed systems scientists implementing business plans for sustainable production of sweetpotato seed.

Each country made presentations of their activities for the period of June-November 2017, with a focus on production capacities, production targets versus actual achievements, and comments on how to improve multiplication rates and reduce production costs; quality management; estimated PBS requirements for the coming season; progress in implementing their business plans and revolving funds; and capacity-building initiatives undertaken. In discussion groups, they deliberated on their successes, lessons, and the improvements they needed to make to improve the sustainability of their PBS production and marketing.

The second Seed System CoP meeting for the year was held 15-17 May 2018 at the Hotel Villa Portofino in Kigali, Rwanda (Milestone Report OBJ5MS1.3Q). In addition, on the 14th of May, the sub-grantee sub-group had a one-day meeting just focused on early generation seed progress. The theme of the meeting was "Engaging youth for improved sweetpotato seed and root production". The meeting was attended by 48 participants (33% women) from 12 SSA countries. There were two learning journeys to youth managed enterprises: one to Serge Ganza's collection center and seed farm; the other to Paola Giriwanyu's farm.

The SPHI Marketing, Processing and Utilization Community of Practice (MPU CoP) held its 5th Annual Meeting on 23-24 April 2018 at the Lotus Hotel in Blantyre, Malawi (Milestone Report OBJ5MS1.3P). The theme of the meeting was **Orange-fleshed Sweetpotato (OFSP) Value Chains for Sustainable Food Systems in Sub-Saharan Africa.** The meeting was attended by 75 participants from 10 countries. There was a panel discussion with private sector players (Euro Ingredients, Universal Industries, Kenya Bureau of Standards (KEBS), Tehilah Bakery and Value Addition Centre, and local farmers) who shared their experiences on the challenges and opportunities of OFSP processing in Africa. Participants visited the Tehilah Bakery and Value Addition Centre at Matindi in Blantyre. The bakery is pioneering the production and commercialization of Orange-fleshed Sweetpotato (OFSP) bread and buns branded Thanzi using OFSP Puree.

The Monitoring, Learning and Evaluation meeting was held on the 12th of February on the ILRI campus in Nairobi, Kenya (Milestone Report 2SS_OBJ5MS1.3N). The agenda focused on getting feedback on experience different users had implementing all or parts of the manual with standardized instruments for collecting data about sweetpotato dissemination efforts that was launched in January 2017. Linked to the MLE meeting was a six-day training course (13-18 February 2018) on the use of STATA, a statistical package being promoted as the best to use for analyzing household survey data as well as principals on data cleaning (Milestone Report 2SS_OBJ5MS1.3.O). This course was sponsored by SASHA and the Roots, Tubers, and Bananas Consortium Research Program (RTB). Thirty-six participants attended the course, 33% of whom were women.

The 17th Sweetpotato *Speed*Breeders and Genomics Annual Meeting was held on 5-8 June, at the Swiss Lenana Mount Hotel in Nairobi, Kenya; with the theme of **'Introducing Next Generation Breeders' Tools and Understanding Winning Varieties"**. Minutes of this meeting (OBJ5MS5.1.1.D) and Power Point presentations and photographs are available on the SKP. Fifty participants (14 of them female) from 14 SSA countries attended the meeting.

During the four-day meeting, speedbreeders shared recent advances in the development and application of tools for data management and genomics assisted breeding. An interactive practical training session on how breeders can use sweetpotatobase and HIDAP for managing, analyzing, storing and sharing data was conducted. The potential of using PhotoSynQ, a tool that measures multiple photosynthetic parameters like quantum yields of photosystems and non-photochemical quenching was introduced during the field trip to the University of Nairobi, Kabete campus. Breeders can now use this tool to select genotypes that have inherent abilities for photoprotection. During the field trip, breeders were able to practice using the Field Application, that permits registering characteristics about a variety directly into a database using tablets. The breeders also shared progress in sweetpotato breeding from their breeding programs highlighting the breeding objectives, approaches, recent variety releases, ongoing trials, promising clones for release and available funding for sweetpotato breeding. Panel discussions captured the perspectives of the breeders on the role of genomic tools in sweetpotato improvement and characteristics of five winning sweetpotato varieties from five SSA countries.

Update on sweetpotato breeding information systems. Together with the Genomics Tools for Sweetpotato Improvement project, led by NCSU, the Boyce Thomson Institute, based at Cornell University in New York, and CIP's Research Information Unit (RIU) have been involved in developing improved trial management software tools (Sweetpotatobase and HIDAP) since 2016. HIDAP stands for Highly Interactive Data Analysis Platform, which is based on R statistical language and Shiny web framework. HIDAP builds on former in-house breeding tools, including CloneSelector (used during SASHA Phase 1). In addition to the features found in CloneSelector, Crop Ontology terminology, interaction with external databases including the Sweetpotatobase through the Breeding API, and improved metadata for open access compliance are better integrated in HIDAP. Moreover, the R statistical program is more easily imbedded in the software, hence installation is easier than for CloneSelector. The first complete version was launched in January 2017 and was tested and revised with the SASHA data manager, Luka Wanjohi, closely involved. The 1.0 version was used in a 2-day training course for the Speedbreeders as part of the May 2017 meeting. Since that meeting, efforts focused on fixing bugs discovered as well as refining key features including the integration of HIDAP and Sweetpotatobase using BrAPI[10]. At the moment, HIDAP can analyze trials on the Sweetpotatobase but cannot upload data to the same. Data are uploaded to the Sweetpotatobase directly from the mobile data collection application (app). Data curation will be implemented within HIDAP for these data before being uploaded to the Sweetpotatobase. The other key feature was building in mobile data collection capability for trials created using HIDAP. HIDAP version 1.0.3 was released in July 2018 and is available at https://research.cip.cgiar.org/gtdms/hidap/. This latest version also contains the Westcott design for analyzing heterosis trial data.

Both HIDAP and Sweetpotatobase offer trial management capabilities. On both systems users can now: elaborate a germplasm list, design a field trial, elaborate a traits list for a trial from CropOntology.org, create a Fieldbook and collect data using the Fieldbook app. The Sweetpotatobase offers management of breeding trials using a centralized database, making it possible to issue trials with unique IDs. Statistical analysis is handled by HIDAP. Figure F5 provides a visual representation of the how the two systems interact.

All the CIP population development programs, including CIP-HQ, are committed to adopt the use of the Sweetpotatobase for trial management and the Fieldbook app for phenotyping. The project will also support national programs that are able to adopt this model, but it is anticipated that a lot of the national programs in SSA are without reliable internet connectivity and will therefore rely on the offline version of HIDAP. CIP's programs in Ghana and Uganda are already actively using the improved tools as well as providing feedback to the different developers on the newest features. During the coming year, national programs requesting support will receive country-level training on HIDAP use.

[10] BrAPI or Breeding API is a set of standard definitions and protocols to enable the creation of tools to help plant breeders to access and exchange information from different breeding databases.

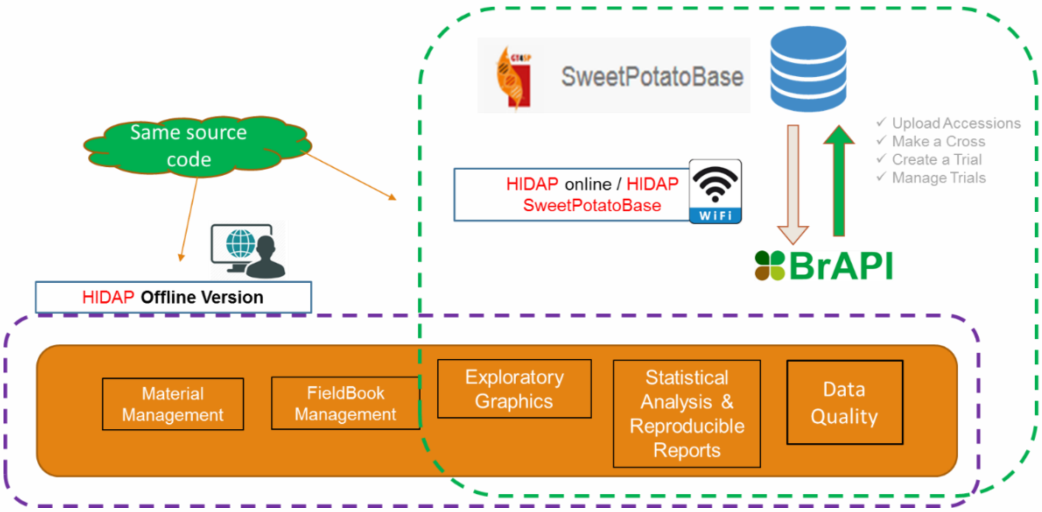


Figure F5. HIDAP and Sweetpotatobase interaction

(3) Monitoring activity: The Development of FANEL-FLOW: Information System for the Food and Nutrition Evaluation Laboratory (FANEL). FANEL-FLOW has been developed to help improve information and workflows management within the FANEL. The system aims to streamline information management as operations within the laboratory as operations expand. Currently, samples being received at the laboratory are manually recorded on a register stored inside the laboratory. These samples are issued with a serialized identification number, and analysis progress is recorded on this register. Sample labels are written by hand. Once analysis is complete, the results are relayed to the relevant parties usually by email.

FANEL-FLOW is an online system accessible via a web browser and requires an active internet connection to work. The system allows online registration of new samples by authorized FANEL staff members. Key data captured during registration include: Sample name, date sample received, free text sample description, sample packaging description, suitable storage temperature, name and contact information of person or organization sending in the sample for analysis and invoicing details. A photo of the sample is also taken using a smartphone and stored as an attachment alongside the other registration data. Upon registration, all samples are automatically issued with a unique sample identification (SID) number and a barcoded label. A list of 27 different types of analyses have been built into FANEL-FLOW and each of these can be independently initialized and tracked within the system for every sample. Upon completion of a given analysis, results are attached to the corresponding FANEL-FLOW analysis task, and free text comments can be added. Once all analyses tasks specified are completed, the sample status is marked as completed. The system will enable the efficiency of the workflow process to be determined.

FANEL-FLOW is a customization of the open-source DRUPAL based software distribution called ERPAL and has been implemented using a MySQL database. Development and testing of FANEL-FLOW by SASHA data manager Luka Wanjohi took approximately 3 calendar months. FANEL-FLOW will be hosted on CIP's corporate intranet for ease of access. The program has been tested with FANEL team-members and is ready to be rolled out.

(4) MLE, capturing dissemination efforts across countries. The second phase of SPHI is focused on "achieving the potential." This means going-to-scale efforts being intensified to reach 10 million African households by 2020 with improved sweetpotato varieties and their diversified use. As SPHI expands, more partners and programs will come under the SPHI umbrella. At the first SPHI technical meeting in 2010, there were 5 distinct sweetpotato projects represented; in year 8 (Y3 in SASHA2), we had 23 projects represented, 9 led by someone other than CIP. In addition, in 2017 there were seven private sector companies engaged in agro-processing attending.

At the SSC meeting, Julius Okello presented the third annual *Status of Sweetpotato in sub-Saharan Africa* report (Milestone report 2SSOBJ5MS1.4.E). As of September 2017, SPHI had reached 4.3 million households, representing 43% of its goal. It was decided at the September SPHI Steering Committee meeting that there a mid-year assessment of the beneficiary status would be conducted, covering the July-December 2017 period. Julius Okello led this effort, with 4,507,639 households in 15 SSA countries being reached by 31 December 2018, meaning we are 45% of the way there towards the SPHI goal of 10 million.

This was the third year of geo-referencing all vine multipliers and collecting standardized information on each multiplier using smartphone with ODK software in 11 countries (Milestone report 2SSOBJ5MS1.4.F). In 2017, 1,118 vine multipliers were registered. OFSP vines are being multiplied on 368 ha, with 0.33 ha as the average land size per vine multiplier; 33 OFSP varieties are being multiplied. The most common varieties of OFSP multiplied (in terms of land area occupied) are 'Kabode', 'Awassa 83', 'Naspot 9', 'Naspot 8', and 'Olympia'. Multipliers could tell the morphological, agronomic, and consumer characteristics of the varieties they multiply. Less than 10% of the vine multipliers had labels on their plots. The main challenges to vine multiplication are drought, phasing out of the projects that recruited or supported the them, and lack of vine market from the fellow farmers.

Collection of quality monitoring and evaluation (M&E) data and their integration into program management activities continued to improve significantly with increased uptake of electronic data collection. Since 2014, SASHA2 has been evaluating the suitability of using smartphones to collect M&E data in sweetpotato research for development in SSA. It has been testing applications using two software packages: ODK, which has been found to be particularly suitable for short surveys used for monitoring activities, and CSPro for Android, which is best for larger, more complex HH surveys.

At the MLE meeting in January 2017, the MLE team[11] launched the tools and associated manual entitled "Tools and Techniques for Monitoring Key Indicators of Sweetpotato Interventions in SSA: A Practitioner's Guide." Data collection tools using paper-based systems, ODK tablet-based systems, and CsPro CABI tablet-based systems accompany the manual. Projects were encouraged to use the modules for the baseline and endline survey work. During the year, we are aware that the Rwanda Feed the Future VISTA–Mozambique project, VISTA–Tanzania, and the Quality Diets for Better Health project in Ethiopia utilized parts of the manual. Their experiences will be reviewed at the MLE meeting in February 2018, with lessons learned used to improve the manual before it is finalized and printed.

(5) Communication activities: SKP and exhibition and meeting participation. The major public instrument for disseminating information is the Sweetpotato Knowledge Portal (SKP), created in open-source Plone software and launched in November 2010. Because of a Sentinel Grant from BMGF, the SASHA project received support to redesign the portal, which was relaunched on 15 February 2016, based on Word Press. Improvements continued throughout 2017, and the SKP is now more user-friendly. There are currently 661 registered users[12] and 2,050 files on the SKP; 47 projects are listed as well. The number of sessions during Year 4 was 35,069, with 2.55 pages visited on average per session. Mobile devices were used in 41% of the session contacts. Appendix F provides more statistics on content and use by country. The heaviest SKP users are based in Kenya and the United States.

The monthly e-newsletter, known as the "Sweetpotato Knowledge Portal E-Digest," is sent out monthly to 1,706 contact addresses, reminding recipients of key events, news articles, and publications accessible on the SKP. Major stories are also included on the RTB and CIP websites. During year 4, a dashboard feature (View Progress) was added to the SKP, which provides users with graphic representative of the number of beneficiaries reached under the SPHI by country and by organization, the number of varieties released since 2009 characterized by key traits, and information on the gender and location of decentralized vine multipliers.

The new SASHA communications officer has focused on getting social media moving by making consistent postings since joining CIP in December 2017. By the end of June 2018, our Facebook engagement figure was 569,869; the

[11] Julius Okello, Temesgen Bocher, Jan Low, and Luka Wanjohi.

[12] Anyone can access and download information on the SKP. However, only registered users can contribute to the SKP.

reach is 928,237; and likes received 11,828[13]. Concerning Twitter, our site now has 515 followers, with 85,000 impressions, 4,016 profile visits, and 116 mentions.

The three 2016 World Food Prize laureates continued to be invited to speak. A major occasion during the reporting period was Robert Mwanga's and Jan Low's participation in a keynote session at the Global Food Security meeting held in Cape Town, South Africa on 3–6 December 2017. In addition, Dr. Low led a panel session on *Is Sustainable Land and Water Management Compatible with Small-Scale Farming?* at the COP23 Global Climate Change meeting in November 2017. Maria Andrade received the 2017 Swaminathan Award for Environmental Protection on August 14, 2017 from the Rotary Club of East Madras, India. Jan Low presented the Roy E. Blaser Endowed Lecture on 22 February 2018 at Virginia Tech university and then gave a keynote address at the Agriculture, Nutrition, and Health Academy meeting held in Accra, Ghana on 25-29th of June. Robert Mwanga presented at the 3rd International Conference on One Medicine One Science (iCOMOS), April 29−May 2, 2018, Minnesota, USA.

A communications intern, Sarah Westby, spent 3 months with CIP and made three 5–6-min videos on our technologies targeting donor and nongovernmental organizations audiences. One describes the Triple S method, the second, a step-by-step guide for setting up Triple S in Ethiopia, and the third the making of OFSP puree at Organi Ltd and its subsequent use in making bread. In addition, KEPHIS coordinated the production of a video describe all activities involved in the pre-basic seed system—the Clean Seed System for Orange-fleshed Sweetpotato Production, which is 7 minutes long. All can be located on the SKP media platform.

(6) Open access commitment. A new open access officer began on 15 March 2018, who spends 50% of his time on SASHA. In the time since he arrived, the following datasets have been prepared, in addition to the breeding data from Uganda:

- Mama SASHA Baseline Survey (Uploaded and Published)
- Mama SASHA COVA Data (Metadata sent for approval by the principal investigator)
- Mama SASHA Diet Recall Study (Metadata sent for approval)
- VISTA Tanzania Baseline Survey (Uploaded, not published)
- VISTA Tanzania Rapid Market Assessment (Uploaded, not published)
- VISTA Tanzania Sweetpotato slip planting density and slip length optimization study (Metadata sent for approval)
- Jumpstarting Endline Nigeria – Food Policy Study (Uploaded, not published)
- Quality Diets for Better Health Baseline (Ethiopia)

In 2016, SASHA2 began using the open access support service being provided by BMGF, which pays journal fees for those qualifying journals (i.e., the journal must permit that the articles are published under a **CC BY 4.0 license**). During 2016, five articles were published as open access publications using this service. During 2017, four more have been published with this support. An additional 14 articles on SASHA related work were published in open access journals. In 2018, two additional articles have been funded with BMGF journal support.

III. 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.

RP1. Breeding. We are committed to continual improvement in our statistical capabilities both among CIP scientists and our partner institutions. A CIM-GIZ integrated expert position at CIP in plant breeding statistics was approved. The position was offered to Dr. De Boek from Belgium, a mathematician with a PhD in statistics, who will begin in July 2018. In country training programs will be conducted during year 5 to assure key breeding programs are using HIDAP and Sweetpotatobase.

The sweetpotato breeding program at HQ received substantial support from USAID, which was suddenly cut in 2017, resulting in having to reduce the number of sites for some trials.

[13] In Facebook, engagement is how many people liked, shared or commented on your posts; reach is how many people saw all the content you posted; and likes are how many people liked your page. In Twitter, followers are those who registered to receive notification that something has been posted.

The Southern African breeding program is based at IIAM's Umbeluzi Research Center. In 2018, IIAM received funding to install an irrigation system, leading to no sweetpotato trials being planted there.

As the NIRS equipment begins to age at all sites, it is emerging that more maintenance and repairs are needed. The lack of in-country capacity to do so, can lead significant periods of time with the NIRS not being utilized.

To keep increase the amount of seed in the West African program, efforts to make controlled crosses in the screenhouse using flowering vines brought in from the field are continuing. In 2017, an MS student experimented with grafting and growth regulator treatments to boost flowering in recalcitrant parents and found that spray application of 40 ppm 2,4-D increased flowering while grafting to floriferous sweetpotato root stocks, was effective at inducing flowering. This work is continuing in 2018 using best rootstock and spray combinations. The Ghana team has also installed polycross nurseries at both Kumasi and Tamale to further boost seed production.

RP2. Weevil Resistance. The funding for the RP2 is now finished. Although the *Bt* approach was not successful, the RNAi approach is promising, and additional funding will be sought to continue this work.

RP3. Seed Systems. Eleven countries have now prepared or gazetted sweetpotato seed standards (in addition, Zambia has sweetpotato standards that need to be revised). However, to ensure appropriate implementation, there is an urgent need for resources to support systematic capacity building for seed producers and seed inspectors. Moreover, while a quality declared seed approach has been advocated, in some cases, the "formalization of the informal" has led to unintended consequences. For example, in Ethiopia, some multipliers stopped producing seed for fear of being prosecuted for not having the right documents.

There has been a turnover in NARI senior management staff in Rwanda (RAB), Mozambique (IIAM), Ethiopia (TARI)and Nigeria (NRCRI). We are committed to ongoing sensitization and advocacy to maintain institutional commitment to implement the business plan and revolving fund. This is necessary to ensure the sustainable production of PBS after project support ends. We continue to support principal investigators in this by engaging senior management in the peer-to-peer review process for the study to validate EGS business models. However, even with the PI (Jan Low) personally visiting the Executive Director of NRCRI, difficulties in getting SGA funds released for sweetpotato activities continues even though funds that had been centralized into the Single Treasury Account, have now been returned to the NRCRI. Discussions continue.

The final 18 months of the seed systems component for sustainable production of sweetpotato PBS assumes that the NARI revolving funds will be used to fund the recurrent costs. We are monitoring this situation closely to reduce the risk that the agreed sustainability strategy will be implemented.

RP4. Postharvest. Developing solar-powered storage facilities for sweetpotato roots has proved to be more challenging than anticipated. The high loss during the latest trial was disappointing and NRI is consulting other experts in the field so that ventilation flow can be improved, etc. However, funds for further NRI support will finish end of September 2018, and we will try and conduct the next trial with local CIP staff.

RP5. SSPs, Knowledge Management, and Governance. The redesign of the SKP proved to be more technically complex than originally thought but the revision is now complete. The RP5 team suffered a major loss when Christine Bukania, our excellent communications officer, left for a higher-level position in Djibouti, just 1 month prior to the annual meeting in 2017. Christine's position has been filled by Faith Njung'e, who since joining in December 2017 has plunged into her job energetically. In addition, the program assistant Tassy Kariuki departed in April 2018, just prior to major meetings. Other CIP regional assisted with the logistics of the Seed Systems and Breeding CoP meetings, including settling in Bernice Wairimu, Kariuki's replacement who joined in May 2018. Departures are related to the difficulty under CIP's current talent management system which makes it difficult to give significant salary increases, even to well-performing staff.

IV. Geographic Areas to Be Served

Geographic Location(s) of Work

Location of Work	Foundation Funding	% of Total Planned Spend	Year 1 Expenditure	Year 2 Expenditure	Year 3 Expenditure	Year 4 Expenditure	Total Expenditure	Balance
	USD	%	USD	USD	USD	USD	USD	USD
Ethiopia	573,155	3%	75,626	98,905	114,086	76,724	365,341	207,815
Kumasi, Ghana	2,293,070	11%	389,650	380,249	432,448	507,725	1,710,072	582,998
Lima & San Ramon, Peru	5,136,145	24%	938,264	1,165,764	940,140	994,233	4,038,401	1,097,745
Maputo, Mozambique	2,559,682	12%	448,648	509,042	386,754	592,467	1,936,910	622,772
Nairobi, Kenya	6,261,777	29%	1,108,167	1,538,651	1,670,671	1,358,985	5,676,474	585,303
Namulonge, Uganda	2,257,778	10%	351,767	424,726	460,598	520,293	1,757,383	500,395
Tanzania	598,271	3%	11,168	77,319	152,524	97,225	338,236	260,035
UK	523,322	2%	161,166	219,361	69,749	58,529	508,806	14,517
Other SSA	848,066	4%	46,669	135,254	156,773	164,794	503,489	344,577
Other World	592,440	3%	155,014		-	-	155,014	437,426
GRAND TOTAL	**21,643,707**	**100%**	**3,686,139**	**4,549,269**	**4,383,742**	**4,370,975**	**16,990,126**	**4,653,581**

V. Geographic Location of Work

Geographic Areas Served

Location Served	Foundation Funding	% of Total Planned Spend	Year 1 Expenditure	Year 2 Expenditure	Year 3 Expenditure	Year 4 Expenditure	Total Expenditure	Balance
	USD	%	USD	USD	USD	USD	USD	USD
Ethiopia	926,737	4%	146,474	202,486	206,606	143,427	698,993	227,744
Kumasi, Ghana	3,732,977	17%	754,680	778,479	704,822	890,904	3,128,885	604,092
Maputo, Mozambique	4,241,184	20%	868,949	1,042,154	631,993	1,033,932	3,577,028	664,156
Kenya	4,445,374	21%	822,475	1,040,174	802,596	342,056	3,007,301	1,438,073
Namulonge, Uganda	3,848,329	18%	681,308	869,536	756,231	916,245	3,223,319	625,009
Tanzania	748,133	3%	21,630	158,293	268,320	178,327	626,571	121,563
SSA in general	1,416,776	7%	90,390	276,904	351,626	383,448	1,102,367	314,409
World in general	2,284,198	11%	300,234	181,244	661,549	482,635	1,625,662	658,536
GRAND TOTAL	**21,643,707**	**100%**	**3,686,139**	**4,549,269**	**4,383,742**	**4,370,975**	**16,990,126**	**4,653,581**

VI. Feedback for the Foundation

As stated earlier, biofortification would never have received the World Food Prize without the tremendous financial and networking support provided by the Foundation to both CIP and HarvestPlus. BMGF's support for sweetpotato was catalytic for getting the potential of this underinvested crop recognized. We are deeply grateful.

We were very pleased to benefit from the Foundation's willingness to support the open access process by providing financial support so that articles in major journals with high open access fees can be made available easily to interested users. The Foundation has also been supporting greater integration of nutritional concerns into agricultural projects and programming, which has encouraged other donors to do likewise. We also appreciate the Foundations convening power and its ability to introduce us to new partners with complementary skill sets.

The Foundation has indicated that CIP needs to increase the number of donors supporting breeding work. We agree but recognize that breeding is an essential function that requires consistent support. Many donors focus on supporting activities that can show returns in a 2–3 year period. We would encourage the Foundation to use its influence to get both existing and newly emerging donors organizations to recognize the importance of consistent and long-term support to breeding efforts, particularly in light of climate change. Moreover, we would like to register our deep concern that the Alliance of a Green Revolution has ceased supporting national breeding programs. Our strength derives from having a strong breeding CoP. We will be proposing setting up a matching fund for national program breeding support under SASHA Phase 3.

VII. 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": N/A

VIII. 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":

______ N/A (no Regulated Activities in project)
___X___ Yes
______ No (if no, please explain below)

The RP2 transgenic weevil resistance component has previously submitted reports demonstrating compliance with all applicable safety, regulatory, ethical, and legal requirements.

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)

IX. Financial Update

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.

By the end of project Year 4, the project spent 91% of allocated budget. This is US$4,370,975 of allocated budget US$4,816,646, with a balance of US$445,671. Project sub-grants have spent 81% of their allocated budget, that is US$432,419 out of allocated budget of US$531,279, with a balance of US$98,860.

Table 1 Year 4 Budget VS Expenditure Status

Budget Category	Year 4: Budget	Year 4: Expenditure	Year 4: Balance	% Spent
	USD	USD	USD	USD
Personnel	1,974,445	1,827,346	147,099	93%
Travel	412,561	404,317	8,244	98%
Sub Grantees	531,279	432,419	98,860	81%
Equipment	60,315	25,992	34,323	43%
Consulting	62,000	35,101	26,899	57%
Other Direct Costs	1,147,788	1,075,672	72,116	94%
Direct Costs, Total	4,188,388	3,800,848	387,540	91%
Indirect Costs, Total	628,258	570,127	58,131	91%
Total	4,816,646	4,370,975	445,671	91%

Year 4 Expenditure Analysis:

Category	% Spent	Explanation
Sub-grants	81%	• ETH Zurich activities implementation was delayed, hence could not report during the project year • NRI UK will only complete their activities between July/Sep 2018, hence carried over their activity funds to Year 5 • Seed systems partners project activities are ongoing and will be completing their activities in 2018. They did not fully utilize Year 4 activity funds which have been carried over to Year 5
Equipment	41%	• Breeding: Major challenges and delay were encountered in purchase of correct netting during the year, but the netting has been identified and purchased during project year 4. The constructions will be completed in project year 5 • Post-Harvest: Mozambique storage facility needed further changes and only arrived at site in June 2018. Further payments to be made.
Consulting	51%	• Post-Harvest handling transporting trials consultant was not engaged in project year 4 until May 2018.

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.

Budget Adjustments

During the first half of year 4 implementation, it was necessary to make budget adjustments as indicated in Tables 2 – 4 below. In most of the budget categories, the variance rates are less than 10%; however, both equipment and consulting budget categories were above 10% which required BMGF approval. The explanation behind these requests are described below.

Year 4:

Subgrants: Modifications to partners' SGAs were finalized during the first half of the year. The seed system subgrants entail an innovative approach to encouraging NARS partners to use their rotation funds increasingly as their subgrants diminish through December 2018. Their new obligated budget varies with allocated budgeted provided in the annual Y3 report. Now, all project subgrant budgets align with their current contractual obligated budget. Overall, this resulted in a reduction of the Y4 total subgrant budget by $16,776.

Because of the need during Y2 and Y3 to move funds approved for NRCRI–Nigeria to an approved consultancy by the Nigeria principal investigator (PI) who is implementing project activities in Nigeria on behalf of NRCRI, the original subgrant budget of $2,444,400 has been reduced by $39,706 (2% of allocated budget) for a new current budget amount of $2,404,695. We note that in February 2018, the blocked funds at NRCRI are now available to be used. We have decided to confirm that all existing funds are used up before considering further transfers to NRCRI.

Capital Equipment: The breeding programs (Southern Africa and Western Africa) had projected to purchase irrigation equipment and color meter. But upon procurement analysis, the cost of irrigation fell under other direct costs, while the color meter was purchased from another project. Hence, we have moved $15,000 from capital equipment to other direct costs.

Consulting: During the first half of the year we realized that the consultancy budget for NRCRI Nigeria (partner) PI had been underestimated, hence we have increased the amount with $9,000. Under the seed systems program, the final payment for consultants for business training under seed systems engaged in Y3 had not been finalized, hence the increase of $6,500 to facilitate their final payment in Y4.

Budget move from Y4 to Y5:

Following adjustments above, we have moved $8,942 from Y4 to Y5 as shown in Table 2, the Y4 budget analysis.

Table 2. Y4 budget ($) versus revised budget

	Budget	Revised Budget	Variance	Variance (%)	Variance	Approval
Budget Categories	**Year 4**	**Year 4**	**Year 4**	**Year 4**	**Year 4**	
Personnel	1,974,445	1,974,445	(0)	0		-
Travel	412,561	412,561	-	0		-
Subgrants	548,055	531,279	(16,776)	-3	Decrease	Project Manager
Capital Equipment	75,315	60,315	(15,000)	-20	Decrease	Jim Lorenzen - BMG
Consulting	46,500	62,000	15,500	33	Increase	Jim Lorenzen - BMG
Other Direct Costs	1,139,288	1,147,788	8,500	1	Increase	Project Manager
Direct Costs, Total	4,196,164	4,188,388	(7,776)	0		
Indirect Costs, Total	629,425	628,258	(1,166)	0		
Total	**4,825,588**	**4,816,646**	**(8,942)**	**0**		

Year 5:

Subgrants: In reference to Y4 budget adjustment, the subgrants budget was reduced with $22,929 in order to fund the NRCRI–Nigeria PI consultancy budget.

Travel: Following budget adjustments in both Y4 and Y5, remaining budget has been used in increasing the SSP, knowledge management, and governance travel budget. The funds will be used to support CoP meetings and annual SPHI meeting.

Consulting: The NRCRI Nigeria (partner) PI consultancy budget had been underestimated, hence provision has been increased with $11,000.

Table 3 presents the Y5 budget analysis, and Table 4 presents the revised project budget ($) as of the end of Y4.

Table 3. Y5 budget ($) versus revised budget as of end of Year 4 (Y4)

Budget Categories	Budget	Revised Budget	Variance	Variance (%)	Variance	Approval Needed From:
Personnel	2,047,504	2,047,504	(0)	0		-
Travel	273,841	293,546	19,705	7	Increase	Project Manager
Subgrants	296,248	273,319	(22,929)	-8	Decrease	Project Manager
Capital Equipment	12,500	12,500	-	0	Decrease	
Consulting	4,000	15,000	11,000	275	Increase	Jim Lorenzen – BMGF
Other Direct Costs	1,014,620	1,014,620	-	0	Increase	
Direct Costs, Total	3,648,714	3,656,490	7,776	0		
Indirect Costs, Total	550,254	551,420	1,166	0		
Total	**4,198,968**	**4,207,910**	**8,942**	**0**		

Table 4. Revised project budget ($) as of end of Year 4 (Y4)

Budget Categories	Expendi-tures	Expendi-tures	Expendi-tures	Revised Budget	Revised Budget	Total Revised Budget	Original Budget	Variance	Vari-ance (%)	Variance
	Y1	**Y2**	**Y3**	**Y4**	**Y5**	**Project Y1–Y5**	**Project Life**			
Personnel	1,459,545	1,585,841	1,721,662	1,974,445	2,047,504	8,788,996	9,456,501	(667,505)	-7	Decrease
Travel	373,832	569,595	507,584	412,561	293,546	2,157,118	2,312,273	(155,156)	-7	Decrease
Subgrants	463,696	628,429	507,972	531,279	273,319	2,404,695	2,444,400	(39,706)	-2	
Capital Equipment	138,289	84,797	46,118	60,315	12,500	342,019	209,000	133,019	64	Increase
Consulting	-	45,494	30,035	62,000	15,000	152,529	31,188	121,341	389	Increase
Other Direct Costs	769,978	1,044,293	998,579	1,147,788	1,014,620	4,975,258	4,367,252	608,007	14	Increase
Direct Costs, Total	3,205,339	3,958,449	3,811,950	4,188,388	3,656,490	18,820,614	18,820,614	(0)	0	
Indirect Costs, Total	480,801	590,821	571,792	628,258	551,420	2,823,092	2,823,092	(0)	0	
Total	**3,686,139**	**4,549,269**	**4,383,742**	**4,816,646**	**4,207,910**	**21,643,706**	**21,643,707**	**(0)**	**0**	

3. Budget Plans for Next Reporting Period

Explain any significant reforecasting, any impact that the reforecasting will have on the total budget, and how your organization will be able to successfully perform within the reforecast budget.

End of Year 4 Carry Over:

Total end of Year 4 balance / carry over amounts to $445,671 as indicated in Table 5 below:

Table 5: End of Year 4 Budget Balance (Year 4 Carry Over)

Budget Category	Year 4: Budget	Year 4: Expenses	Year 4: Balance	% Spent
	USD	USD	USD	%
Personnel	**1,974,445**	1,827,346	**147,099**	93%
Travel	**412,561**	404,317	**8,244**	98%
Sub-grants	**531,279**	432,419	**98,860**	81%
Capital Equipment	**60,315**	25,992	**34,323**	43%
Consulting	**62,000**	35,101	**26,899**	57%
Other Direct Costs	**1,147,788**	1,075,672	**72,116**	94%
Direct Costs, Total	**4,188,388**	**3,800,848**	**387,540**	**91%**
Indirect Costs, Total	**628,258**	570,127	**58,131**	91%
Total	**4,816,646**	**4,370,975**	**445,671**	**91%**

End of Year 4 Carry Over Distribution:

We are proposing for approval, an increase of approved Year 5 budget with the total Year 4 Carry over of $445,671. The redistribution will enable us to achieve our targets as the funds have been reallocated to ensure that delayed milestones are accelerated. Please see distribution and net effect analysis in Table 6 and 7 below:

Year 5 Proposed Budget Notes:

Personnel	Personnel budget in final project year has increased, this being the final project year and partial staff separation cost have been considered in the budget.
Sub Grants	Partners funding has been increased as indicated below: **Breeding:** to continue to support breeding activities with FIFAMANOR (Madagascar); Burundi PhD student (will now finish in Dec 2018); Cold Tolerance activities in Kenya (Release committee insisting on additional season) and ETH Zurich (Iron bioavailability study—not completed in year 4) **Seed Systems:** partners are implementing their business plans and wrap up. **Post-Harvest:** NRI completion and wrap up of project activities which include storage trial and case study for storage scenarios
Equipment	**Breeding program:** Equipment provision is to cater for screen house construction where major setbacks and delays were experienced in procurement of the nets. The correct netting has already been identified and purchased, hence construction will proceed. **Post-Harvest:** provision is for wrapping up the storage trial facility investment

Table 6: Year 5 Revised Budget and Variances

Budget Category	Year 5: Budget	Revised Year 5: Budget	Variance Amount	Variance Percentage	Net Effect	Approval
	USD	USD	USD	%		
Personnel	**2,047,504**	2,064,509	17,005	1%	Increase	Project Manager
Travel	**293,546**	308,841	15,295	5%	Increase	Project Manager
Sub-grants	**273,319**	451,661	178,341	65%	Increase	Jim Lorenzen - BMGF
Capital Equipment	**12,500**	69,000	56,500	452%	Increase	Jim Lorenzen - BMGF
Consulting	**15,000**	13,500	(1,500)	-10%	Decrease	Project Manager
Other Direct Costs	**1,014,620**	1,136,519	121,898	12%	Increase	Jim Lorenzen - BMGF
Direct Costs, Total	**3,656,490**	**4,044,030**	**387,540**	**11%**		
Indirect Costs, Total	**551,420**	609,551	58,131	11%		
Total	**4,207,910**	**4,653,581**	**445,671**	**11%**		

Table 7: Project Budget with Proposed Year 5 Budget

	Expenses	Expenses	Expenses	Expenses	Revised Budget	Total Revised Budget	Original Budget	Variance	Variance	Variance
Budget Categories	**Year 1**	**Year 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**Y1-Y5**	**Project Life**	**Amount**	**Percentate**	**Effect**
	USD	USD	USD	USD	USD		USD	USD	%	
Personnel	**1,459,545**	1,585,841	1,721,662	1,827,346	2,064,509	**8,658,902**	**9,456,501**	(797,599)	-8%	Decrease
Travel	**373,832**	569,595	507,584	404,317	308,841	**2,164,169**	**2,312,273**	(148,105)	-6%	Decrease
Sub-grants	**463,696**	628,429	507,972	432,419	451,661	**2,484,176**	**2,444,400**	39,775	2%	Increase
Capital Equipment	**138,289**	84,797	46,118	25,992	69,000	**364,196**	**209,000**	155,196	74%	Increase
Consulting	-	45,494	30,035	35,101	13,500	**124,130**	**31,188**	92,942	298%	Increase
Other Direct Costs	**769,978**	1,044,293	998,579	1,075,672	1,136,519	**5,025,041**	**4,367,252**	657,789	15%	Increase
Direct Costs, Total	**3,205,339**	**3,958,449**	**3,811,950**	**3,800,848**	**4,044,030**	**18,820,614**	**18,820,614**	**(0)**	**0%**	
Indirect Costs, Total	480,801	590,821	571,792	570,127	609,551	**2,823,093**	2,823,092	**0**	**0%**	
Total	**3,686,139**	**4,549,269**	**4,383,742**	**4,370,975**	**4,653,581**	**21,643,707**	**21,643,707**	**0**	**0%**	

1. Sub-awards (if applicable)

	Organization Name	Actual Disbursement for this Reporting Period	Total Disbursed from Primary Awardee to Sub to Date	Total Sub-awardee Spent to Date	Total Contracted Amount
		U.S.$	U.S.$	U.S.$	U.S.$
1	Burundi-Support for Breeding (PhD training at Makerere plus field support)	40,134	85,637	91,408	83,126
2	Kenya- Cold tolerance	28,746	82,526	82,526	67,752
3	FIompiana Fambolena Malagasy Norveziana (FIFAMANOR), Madagascar	10,706	79,016	80,171	77,547
4	ETH Zurich (Sub-grant signed June 2018)	-	-	-	81,218
5	Ghent University IPBO (Belgium)	0	63,014	63,014	63,014
6	BecA/ILRI platform and training	-	35,296	35,296	35,296
7	Donald Danforth Plant Science Centre (DDPSC)	-	92,000	92,000	92,000
8	Rwanda Agricultural Board (RAB)	16,703	108,040	104,488	112,064
9	Sugar Research Institute (SRI) - Tanzania	9,701	110,040	109,626	111,943
10	South Agricultural Research Institute (SARI), SNNPR Ethiopia	22,385	82,941	76,423	74,066
11	Tigray Agricultural Research Institute (TARI) - Ethiopia	4,435	55,485	58,173	66,825
12	Department of Agricultural Research Services (DARS) - Malawi	0	38,910	48,675	48,715
13	Institut de l'Environnement et de Recherches Agricoles (INERA)	17,537	59,152	52,932	48,166
14	Zambia Agriculture Research Institute (ZARI), Zambia	13,656	81,883	76,199	79,528
15	National Root Crops Research Institute (NRCRI), Nigeria	8,294	25,599	45,818	47,185
16	CSIR-Crops Research Institute	23,182	49,340	47,117	41,749
17	Biocrops (U)Ltd	9,987	28,837	30,207	38,462
18	National Agricultural Research Organization (NARO) - Rice Program	418	25,242	23,908	24,823
19	National Agricultural Research Organization (NARO), NaCRRI - Uganda	11,941	51,148	48,303	50,014
20	Instituto de Investigação Agrária de Moçambique (IIAM), Mozambique	24,959	83,352	77,068	82,896
21	Kenya Plant Health Inspectorate service (KEPHIS), Kenya	14,954	127,400	117,403	120,833
22	Seed Systems Sub Grants Community of Practice	(0)	109,137	109,137	111,163
23	FERA Science Limited (FERA)	-	43,803	43,803	43,803
24	Univ Development Studies (UDS), Ghana	(0)	24,000	24,000	24,000
25	Natural Resources Institute (NRI) Faculty of Engineering and Science, University of Greenwich, UK	51,365	444,943	465,002	475,370
26	Euro Ingredients Ltd, Kenya	(0)	29,817	29,817	29,817
		309,102	2,016,557	2,032,515	2,131,375

2. Other Sources of Support (if applicable)

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

CIP supported the project in absorbing other direct costs amounting to US$507,732. Hence, during the project year, total expenditures amounted to US$4,878,707, being US$4,370,975 funded by BMGF and US$507,732 funded by CIP in support of the project.

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

Interest earned in project Y4 amounts to $506, which will be plowed back into project implementation.

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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

APPENDIX A. RESULTS FRAMEWORK: PROGRESS ON SASHA2 AT THE END OF YEAR 4

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
1.1.1	MA & RM	Studies demonstrating that can achieve significant GG (2% per year in yield) in 2 years in early generations and 4 years for selected varieties	6	2019	On track	6	2019	Yr1: Results (average root yields) from unreplicated trial from Namulonge of yield gains above 2% will be confirmed from analyzed data from multiple sites; Data from several trials available in Mozambique & gain above 2% Y2: 7 clones in Mozambique already released on 29th Feb 2016. Dec 2015: established genetic gain trials in Maputo & Zambézia; Heterotic increment in Uganda 16% based on 8 parents X 8 parents crossing (1196 clones); Examining yield of parents enables selection for better parents. heterosis study for drought tolerance in Mozambique (2016 harvest) indicated an increase in yield for the inter population AxB over Intra population A. These results confirm our previous findings. In Uganda, there is a need to confirm the heterotic groups using testers or work with a different set of parents. In Mozambique, registered 9 clones in HortScience and released 7 in 2016. Moz: Four advanced clones in 2015 multilocational trials had significantly higher yield than the international and local check clones; Yr3: 25 more trials harvested in 2016 and 2017. Genetic gain trials were harvested at five locations (four in Mozambique) and one in Mansa, Zambia. Year of release was significantly different among the measured traits. Results from regression analysis indicated an annual gain of 3.03% on total storage root yield, 2.36% on commercial storage root yield, both on dry weight basis and 1.0% on vine yield on fresh weight basis. At HQ: from 1992-2.014 at 120 days: 0.36 tons/yr for storage root yield; for 90-day period 0.18 tons/yr. **Yr4.** Moz has one remaining trial to be harvested in Zambia and one additional trial in Umbeluzi. OT will use Westcott design to capture genetic gain. Multi-locational trials will result in variety release in 2019. Several more trials were planted and harvested during this quarter. Data from on-station trials in Uganda show 3.1% genetic gain (0.41 t/year).	85	85	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	**Year**		**Mon**	**Year**		**Y4**	**Annual**	
1.1.2	WG	Estimates of yield gains achievable by reciprocal recurrent selection (RRS) in sweetpotato	6	2019	On track			Yr1: Have crossed with partially inbred populations, selected parents & crossed again. Y2: Seeds need to be planted out once have enough seed & then one selection cycle will be done. **Y3:** Planted B (non-sweet) & C (high Fe and Zn) in Satipo in November 2016 for Fe & Zn; harvested in April 2017. Under analysis after harvesting: 9881 H1 WAE (early maturing) clones, 3742 H1 NSSP (non-sweet) clones, 3292 H1 HIFE (high Fe) clones in field experiments plus each parent 8 plots and each grandparent 8 plots (80 x 8). **Yr4: All field experiments of this large study in Peru were completed in December 2017. In all H1 populations large genetic gains were observed. In H1 populations storage root yield genetic gain estimates ranged from 68.8 to 110.3%.** Heterosis increments for storage root yield in hybrid population H1 ranged from 9.3 to 37.6%. All H1 populations exhibit variety ability. These H1 studies at CIP-HQ provide useful information for (i) SPVD resistance breeding at the breeding platform Namulonge, (ii) selecting testers and elite crossings in sweetpotato population hybrid breeding, and for genome wide prediction in sweetpotato.	65	65	100
1.1.3	RM	At least 14 African sweetpotato breeders breed using the latest knowledge & efficient methods	6	2019	On track			Yr1: 14th breeders meeting held in Mukono, Uganda, June 2-5, 2015 June 2015. Needs of breeding programs discussed during meeting. Field day emphasized diversified end user involvement in varietal selection. Yr2: Backstopping trips made to Madagascar (2015/07) and Burundi (2016/02); Ghana & Ethiopia received AGRA breeding grants, but funds not given to Ethiopia because of strategy change at AGRA **Yr3:** Backstopping visit to Burundi (Oct 2016) - worked on plans for breeding trials and supplying OFSP planting materials to partners. Breeders from 14 SSA countries agreed to mainstream beta-carotene trait-- at least 50% of clones submitted for release will be orange-fleshed. The 16th Annual Sweetpotato SpeedBreeders and Genomics Community of Practice Meeting held in June 2017 in Kigali updated breeders on progress in sweetpotato genomics and launched HIDAP program for analyzing breeding data. integration of HIDAP and Sweetpotatobase in progress. **Yr4:** A training on applied use of statistics for senior sweetpotato breeders was held in Kumasi, Ghana 11-19 January 2018 with the idea that these breeders would then train others. Progress on integrating HIDAP and SweetpotatoBase continued to be made, enabling training on program use to be a core part of the 17th annual	65	65	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
								SpeedBreeders & Genomics CoP meeting, held 5-8 June 2018 in Nairobi, Kenya. The three sweetpotato support platforms and the national programs (Ghana and Uganda) actively use HIDAP and Sweetpotatobase.			
1.2.1	RM	At least 250,000 seeds with increased frequencies of resistance to SPVD (2–10%) disseminated to at least 10 NARS partners	6	2019	Almost Achieved			Yr1: First results on frequencies for SPVD resistant phenotypes were presented at Sweetpotato Breeders meeting June 2-5, 2015, Mukono, Uganda. Seed distributed will be families with high frequencies of SPVD resistant phenotypes. Total of 159,680 seeds were distributed by June 5, 2015. **Yr3Qtr2:** More seed has been generated in 2016 for sharing with NARS partners (341,463 during July-Dec 2016 period). The genomics project at BecA was allocated 13 families (903 seeds) by CIP/Uganda. To date NARS partners have received 260,316 seeds. Yr4: During July 2017–December 2017), 157,830 poly-cross seeds (44,783 and 113,047 from crossing blocks A and B, respectively) were generated. By June 2018, a total of 303,047 seeds had been sent to 10 countries. From mid-parent values the frequency of SPVD resistant parents (field resistance) is 48%.	60	60	100
1.2.3	RM	Selected hybrid progeny demonstrating yield jumps of 10–20% from populations with SPVD resistance	6	2019	On track			Yr1: Hybrid progeny with target yield jumps will identified in populations in objective 1.1.1 study. Preliminary results from Namulonge show some high SPVD resistant progeny from inter-population crosses with yield jumps Yr2: Pop A has 80 parents; Pop B 50 parents; In Ug: clear evidence of heterotic gain after 3 seasons; in addition, clear most heterotic increment potential comes from a combination of a few parents. Next step will be to eliminate bad parents from the two populations (crossing blocks) Yr4: Following the heterosis trials (previously reported in 2016), 55 genotypes were selected for further evaluation. Eight genotypes combining orange flesh roots with high storage root yield potential, low SPVD, Alternaria blight and weevil damage scores, were selected and planted in new advanced yield trials planted in 2017B trials. Results are available. **Yr4:** Sweetpotato genotypes currently used as parents in crossing blocks A and B in Uganda were evaluated in three sites (10 plants per plot, 3 reps, RCBD). The frequency of SPVD resistance (field resistance) parents in population Uganda A and Pop Uganda B from mid-parent values is about 48%. Field trials to validate increase in SPVD resistance based on progenies are underway in Uganda.	60	60	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
1.3.1	MA	At least 150,000 seeds with drought-tolerance genes disseminated to at least 10 NARS partners in SSA and SWCA	6	2019	Achieved			Yr1: 35,000 seeds distributed to 7 SSA NARS Yr2: 102,923 seeds collected (25,000 controlled crosses) available; 45,000 seeds available- two requests (6,570 to Madagascar, Bangladesh) by Jan 2016; Y2: Distributed 42,600 seeds to 11 other countries (June 2016) **Y3**: 33,000 true OFSP seed were disseminated to 11 NARS from SSA and 11,400 PFSP seed ready for distribution once import permits are sent from 5 NARS in SEA. Total distributed = 128,570 for the past 3 years. 2016 crossing block established. seeds collected in the two sites. New distribution done during the breeders meeting in May and the milestones will be accomplished 100%. A total of 344 006 true seeds were harvested from 1104 families in the three crossing blocks established in 2017 in Mozambique. Seed production by location: Umbeluzi OFSP produced 24,463 true seeds from 326 families (controlled crosses) while 145, 554 true seed (64 families) were harvested from polycrosses. Gurue OFSP produced 38,894 true seeds from 347 families (controlled crosses) and 69,988 true seed (63 families) harvested from polycrosses. Meanwhile, the purple-fleshed crossing block established in Gurue gave rise to 21,467 true seeds (257 families) from controlled crosses and 43,640 true seed from polycrosses (47 families). Seed dissemination in 2018 was based on these true seed produced in 2017 crossing blocks. A total of 5 000 true seeds from 50 families harvested in 2017 from polycrosses at Umbeluzi Research Station were sent to Brazil, CERAT, UNESP, Câmpus de Botucatu, in March 2018. Another set of true seeds were distributed to NARS partners from Burkina Faso, Burundi, Rwanda, Cote d'Ivoire, Nigeria, Zambia, Kenya, Ghana, Malawi, Ethiopia, South Africa and Madagascar during the breeders meeting in June, Nairobi, Kenya. Each NARS partner received 3 000 true seeds.	80	80	100
1.3.3	MA	Hybrid progeny exhibiting yield jump of 10–20% in hybrids from populations with drought tolerance & enhanced efficiency for drought tolerance breeding	6	2019	On track			Yr1: Population A is in Umbeluzi with 68 parents; Population B in Gurue with 56 parents Yr2: Pop A with 66 parents & Population B with 56 parents & 2nd round of progeny planted 20 Aug 2015. At Umbeluzi 2820 OT planted & Gurue 1736 OT planted all OFSP. Also, in Gurue another OT (1200) planted with PFSP population. Three crossing blocks planted in December 2015 (being two in Gurue and one in Maputo. Crossing. Y2: OT (from Dec 2015 crossing) planted in June 2016 has 2,820 OFSP clones (Umbeluzi); In Gurue: 2,400 OFSP clones; 2,106 (purple-fleshed). In Feb 2016, 7 new varieties released: 3 OFSP for	70	70	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
								dual purpose; 2 OFSP for food only; and 3 purple-fleshed. 2nd cycle of varietal release using accelerated breeding in Mozambique. **Yr3**: Three unreplicated observation trials (OT) were harvested from two treatments (optimum conditions & water stressed) at Umbeluzi (2820 OFSP clones) and Gurue (1868 OFSP & 1246 PFSP clones). From these OTs, 499 OFSP and 239 PFSP clones were advanced to preliminary yield trials (PYT) at Gurue based on higher storage root yield than check clones. At Umbeluzi, 294 OFSP clones were advanced to PYT. There were highly significant differences (P<0.0001) for storage root yield between the check clones (17.89 t/ha) and the experimental clones (31.28 t/ha) at Umbeluzi. **Yr4:** Two OFSP seedling nurseries were established at Maputo and Gurue each with 3000 clones. The clones were planted as OTs in July 2017 following the Westcott design. In 2017: A total of 3 (OTs) were established at Umbeluzi (3000 new clones; 2 check clones; 62 parents), Gurue (2667 new clones; 2 check clones; 51 parents) and one from purple-fleshed crossing block at Gurue (1695 new clones; 2 check clones 35 parents). Based on vine vigor, root yield, root shape and size as well as weevil tolerance 125 & 168 clones were advanced to PTs at Umbeluzi and Gurue, respectively. The quality laboratory has processed slightly more than 8,000 root samples from OTs harvested at Umbeluzi (both treatments) and Gurue (irrigated treatment). The drought tolerance trials were harvested also for the third season at Umbeluzi and variation for sensitiveness was observed among genotypes. 3,000 seeds from controlled crosses done in the 2017 crossing block at Umbeluzi were scarified and a seedling nursery established in Maputo. These will be planted in OTs in July 2018.			
1.3.4	MA	Clones with 200% RDA for young children of pro-vitamin A, 25% RDA of Fe, and 35% RDA of Zn under high intakes	6	2019	On track			Yr1 Fe and Zn measured with NIRS in Mozambique Yr2: 200 clones identified and were sent to Lima for confirmation with XFR on 22 Feb. samples were sent to Lima and results obtained. Some results need confirmation in an Australian lab. We have chosen our parents for the 2016 crossing blocks based on high Iron and Zinc obtained from NIRS & new crossing block established in Dec 2015 (started collecting seed in March 2016). **Yr3Qtr2:** Results from CSIRO obtained indicating 2 genotypes with high FE and borderline contamination; The OTs were harvested from November to December 2016 and NIRS have been read for clones planted at Umbeluzi. Two crossing blocks were renewed in Dec 2016. **Yr3:** The	70	70	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
								OTs were harvested from November to December 2016 and NIRS have been read for clones planted in Mozambique. The best 200 clones with high iron and zinc (NIRS) from OT at Umbeluzi were sent to Lima for determination of Fe & Zn using the XFR methodology. **Yr4:** A total of 30 clones had Fe content higher than the targeted 2.3 mg/100g DW in our milestones and sent to Australia for confirmation. Only one of these clones was found not to be contaminated. The clone is MUSG15052-2 was selected to proceed for a multi-feeding trial. It's rich in Fe (44mg/kg) and was sent to FANEL and ETH-Zurich for Vitamin C analysis on 16 Nov. The clone MUSG15052-2 was rapidly multiplied at Nwalate and would be planted at Umbeluzi in Jan 2018 for the feeding trial in Mozambique. Hand crossings were initiated in May 2017 and lasted until September 2017 at both Gurue and Umbeluzi. In 2017: A total of 3 (OTs). Umbeluzi (3000 new clones; 2 check clones; 62 parents), Gurue (2667 new clones; 2 check clones; 51 parents) and one from purple-fleshed crossing block at Gurue (1695 new clones; 2 check clones 35 parents). The trials were planted in a Westcott design. > 8 000 root samples were processed in the quality laboratory from the harvested OTs at Umbeluzi (both irrigated & not irrigated treatments) and Gurue (irrigated treatment). Some selected number of botanical seed from milestone 1.3.1 were be planted as OTs across the two locations and screened for beta-carotene, iron and zinc. All trials harvested as planned. Quality lab is still drying the samples for NIRS reading and to do the selection. Preparation for the multiple meal feeding trial on-going in Malawi as Mozambique site did not work out. Ethics clearance expected in mid-August 2018. A trial using 15 OFSP varieties was conducted comparing nutrient levels in peeled vs unpeeled roots using NIRS. The no peeling treatment had significantly higher beta-carotene, Fe, Zn and sucrose than the peeling treatment.			
1.4.1	TC	At least 100,000 seeds with less sweet taste genes disseminated to at least 10 NARS partners in SSA and SWCA	6	2019	On track			Yr1: Distributed 5,580 seed distributed to Burkina Faso & Nigeria; plan put in place to improve seed output Yr2: Preparing OPV seed; Yr2 3rd quarter - Plan for technician from Lima to trouble shoot crossing; Yr 2 4th quarter - with comprehensive approach to improving hybridization, including 4 month visit of best technician from Lima to Ghana, we are confident that using grafting, short day treatments and protected environment, that	70	40	57

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
								we will boost production of seed from all cross combinations required. Given that our major deliverables come in years 4 and 5, we are confident of getting back on track with seed production capacity, while characterizing parental material for postharvest and quality attributes during year three. Yr 3, Q1 update: good progress underway with crossing and seed production in screenhouses. **Yr 3, Q2:** ~20,000 seeds produced at Kumasi from 31 of 34 parents used in the crossing block. Key to success was protected environment. Seed available for Ghana breeding and international distribution. **Mid-Yr4:** Since July 2017, 9,091 seed from 35 out of 45 parents, with crossing continuing. **End Yr4.** 21,733 seeds produced, mostly from controlled pollinations in screenhouse. 1200 open pollinated seeds from two parents, Faara and Otoo, were shared with 10 NARS partners. Arrangements are being made to share an additional 10,000 seeds, mostly from controlled crosses, with NARS in Nigeria and Burkina Faso. Seed includes crosses between both countries' best performing OFSP varieties. Extra measures are being taken to produce more seed in year 5 using polycrosses with prolifically flowering parents at both northern and southern locations, and using grafting and hormonal treatment (2,4-D sprays) set out as an experiment.			
1.4.3	TC	Hybrid progeny with yield jump of 10–20% from less sweet, less perishable parents	6	2019	On track			Yr1: Approach to formulating the populations will be based now on agro-ecology (Northern & Southern); initial approach of population B material did not work. Yr2: Will separate populations using progeny performance & fingerprinting; Yr 2 end update - Evaluation of progenies for heterosis increment complemented by molecular characterization initiated. Will be further pursued in year 3. Tester development for further allocation to heterotic groups will also be part of the year 3 activities. **Yr 3:** Separate populations in north and south continue under development. MS student Nikiema completed data collection, with preliminary results regarding molecular and yield assessments for identifying heterotic combinations. Characterization of parental panel for utilization and postharvest traits continuing. Yr 3 Q4: Large trial underway to repeat the previous minimal effort of Nikiema. **Mid-Yr4:** Large trial data collection completed and results being analyzed. 45 parents will be fingerprinted and characterized for perishability. **End Yr4:** Seemingly robust results of progeny assessment of	70	70	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
								parents and progenies from program, including low sweet and less perishable genotypes produced large heterosis increments. Based on heterosis increments for yield, we have separated parents in to 2 populations. These are to be confirmed through ongoing genotyping. We feel confident that we are back on track with respect to this milestone.			
2.1.1	MG	Between 15 to 30 transgenic events per new cry gene constructs	6	2014	Achieved			Yr1: 39 produced at ABL Peru, 2 at BecA Kenya, and 125 at DDPSC in USA	100	100	100
2.1.3	MG	At least 3–5 storage roots per transgenic event	4	2015	Achieved	2	2016	Yr1: Storage roots are harvested in BecA greenhouse regularly. Y2: 80% of the transgenic events produced roots. The missing 20% are likely due to difficulties to produce storage roots in greenhouse which is a problem experienced at all three locations (ABL, Danforth, BecA)	100	100	100
2.1.4	MG	Mortality assessment for each transgenic event with enough *Cry* protein to expect efficacy	7	2015	Achieved	12	2016	All the transgenic events were tested at least once for efficacy. Several have been tested twice. Those events which seemed to have apparent differences with the untransformed storage roots (12) were retested and turned out to be susceptible.	100	100	100
2.2.2	MG	Efficacy data for several dsRNA (single and in combination) against weevil larvae	6	2017	Behind Schedule	12	2017	Two of the five RNAi gene constructs used for agro-infection. To date, no transgenic events have yet been confirmed. Regenerants from agro-infected somatic embryos will be harvested in the next couple of months. New funding will be sought to test them for resistance against weevils.	100	100	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
3.1.1	MM	Brochure with improved protocols for implementing Triple S method & study of uptake	6	2017	Almost Achieved	12	2018	EndY3: W. Kenya training and validating will be completed by Sept17; Gh & Nigeria see JS Final Report. Ethiopia: completed in SNNPR; Tigray completion due by Dec17; Ug under MENU projects trained 1,500 farmers in 5 districts and distributed 2017 Triple S calendars; TZ 155 farmers trained under VISTA: Burkina Faso testing with 54 HHs and 5 DVMS; Moz 211 farmers trained under VISTA & Irish Aid. **MidY4:** 3 types of training materials (ToT guidelines, farmers' handouts and flip chart training tool) have now been completed. These are in process of translation into different languages according to need. Triple S was selected as one of three technologies for support under the new RTB innovation and scaling fund ($700,000). This will be done in Ghana and Ethiopia in 2018; and discussions are on-going with CRS and HKI for integration of Triple S into ag-nut projects with OFSP vine dissemination components. Western Kenya - validation study - write up in process by Agili. Awaiting clarification on outcome of H+ study on uptake of Triple S. VISTA Tanzania endline survey included Triple S question, and this is needed for all baseline and endline survey modules (MLE link). **Y4Q3:** Brochure and training materials finalized, and 50 sets printed for distribution. Triple S questions to be included in Ethiopia IA an Emergency project endlines. Follow up on H+ study on uptake still needed **EndY4:** Triple S training materials distributed across 8 countries. Milestone complete except for on-going monitoring and endline studies assessing uptake.	100	95	95
3.1.2	MM	Report on validation of PBS production methods and models in at least 10 national programs	1	2019	On track	3	2019	Y2 Q1: SGA with 8 institutions (7 countries) supporting construction/rehabilitation & pre-basic seed production underway. Mid-year 2: Additional SGAs signed with Ghana (CRI) and BioCrops (U) Ltd. NARO-Rice in preparation. (Pre-basic seed production: 11 countries, 13 institutions). Business plans submitted by 10 institutions. Sandponics established in Kenya. Irrigation study for vine multiplication established in Tanzania and Ethiopia. Established CoP sub-group on Sandponics (BW). EndY2. SGA countries making progress on technical components. Countries doing sandponics need systematic data collection to compare with conventional. Y3Q1: SGAs continuing implementation; slow turnaround of financial reporting. continuing challenges with water and electricity supply in TC labs and drought affecting demand	70	70	100

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								for vines along the seed VC. Preparations for SGA review meeting in December. Methodology for validation study under preparation. **Yr3:** 2,029,074 pre-basic and 7,103,890 basic cuttings production reported; 11 of 13 institutions have undertaken virus testing; 9 of 13 institutions supported visual inspections of basic multipliers; 67% of 12 institutions reported income to revolving fund; Methodology for EGS/PBS validation study prepared and piloted with KEPHIS & RAB. Business plan templates revised to link income from RF and SGA funds, to total production costs; M**idY4:** Y4 SGA modifications include bizplan cost template, allocation of costs of production to rotation funds (RFs), linked to the SGA funds used for marketing, training and admin costs; and projections for sales targets, revenues and balance of RF anticipated by end Dec 2018, when project support will finish. CRI conducted EGS & business plan institutionalization assessment for KEPHIS. July-Nov 2017: 413,607 pre-basic and 2,535,494 basic cuttings production reported; 7 of 13 institutions have undertaken virus testing; 10 of 13 institutions supported visual inspections of basic multipliers; 9 of 12 institutions reported income to revolving fund. Costings and price structure updated for: 6 out of 13 institutions. EGS validation peer assessment completed for: RAB, KEPHIS, INERA **End Y4:** TOTAL 803,043 pre-basic and 4,918,964 basic cuttings production reported; 10 of 13 institutions have undertaken virus testing during year; 12 of 13 institutions supported visual inspections of basic multipliers during year; 6 (5 tbc after FR) of 12 institutions reported income to revolving fund. Costings and price structure updated for: 10 out of 13 institutions.			
3.1.4	JK	Report evaluating the effect of Begomoviruses on yields	6	2018	Behind Schedule	12	18	Yr1: Bramwel Wanjala hired and trained one month in Lima, Peru and 1 week in Uganda; Research protocol developed, and material infected with begomoviruses at KEPHIS obtained. Mid-Year 2: PhD research protocol approved by University. NCM-ELISA & PCR testing on plants at KEPHIS with symptoms for begomoviruses showed negative using NCM-ELISA and 50% positive using PCR. By end Yr2: Field samples collected in 4 out of 6 major growing areas of Kenya. **Yr3:** Collected field data in 5th region of Kenya, tested 400 samples for begomovirus infection, infected two varieties with viruses for field trials. Evaluate effect of Begomovirus on yield.	100	95	95

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								Two varieties (Ejumula and Kakamega) graft inoculated with different virus combination. Field experiments to be set up un July 2017. **Mid-Yr4:** 1st field trial completed. 2nd trial for yield assessment planted Dec 2017, for harvesting May 2017. **End-Yr4:** Data collected and analysis underway. Report expected 1 Sept 2018.			
3.1.5	MM	Cost study on different methods of pre-basic seed production	1	2019	Behind Schedule			Y2 Q1: NARIs challenged with developing own business plans as tool to manage pre-basic seed production and sales as part of RF. Contracted consultant to visit & work with each NARI (KEPHIS, RAB, SRI, ZARI visits completed; IIAM, DARS, SARI/TARI in progress). Y2Q3: Synthesis document of 10 bizplans prepared & captured 10 take home messages; Bizplan preparation started in Ghana, Nigeria and BF. Institutionalization framework developed to monitor implementation of bizplans. Data collection templates to validate existing cost structures for bizplans and cost structure for sandponics under preparation. Y3Q1: Real time cost data collection on-going in Gh, Nig, LZARDI, Ke, (BF) Guidelines for updating costings for other countries prepared. Revised protocol for sandponics vs conventional screen house multiplication for new set up of experiment; **Yr3Qtr2:** improved real time cost data collection templates in use by CRI, KEPHIS, NRCRI and LZARDI. Light templates developed for other countries. Data collection for sandponics on-going, but design of experiment to be revisited (again). **End Y3:** Real time cost data collection completed for KEPHIS and CRI, with NRCRI and SRI almost completed. Light data collection template in use by the other institutions. Sandponics vs Conventional comparative study on costs delayed. New Post Doc in Uganda will take over regional backstopping responsibilities. **Yr4 mid-year:** Real time data for PBS costs collected and analyzed for 3 NARIs; 3 NARIs updated costs and prices using recall system. Financial cost benefit analysis of sandponics vs conventional method showed that sandponics was not more cost effective. Cost of nutrients, higher irrigation related costs for sandponics and limited number of ratoons are some of the reasons for this. Ssali took over lead of sandponics and redesigned study. MSc intern identified to conduct study at KEPHIS. New sandponics experiment in Uganda has 2 objectives: 1) determining the effect of Gibberellic Acid (GA) on sweetpotato vine yields in sandponic systems	80	70	88

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								and; 2) sequentially increasing the nitrogen levels of the nutrient solution in sweetpotato sandponic systems. **End Y4:** Sandponics nutrient media optimization trial at KEPHIS PQS shown N at 200ppm, and appropriate levels of: N, P, Ca, S and B completed. New experiment established to compare this optimized nutrient media with conventional. Ratooning study on-going in Uganda.			
3.2.1	JK	Availability of disease-free pre-basic material within 12 months of initiating clean-up	6	2017	Behind Schedule	11	2018	Yr1: 3rd Iteration of ClonDiag functional after resolving minor problems Y42: 4th Iteration necessary and delivered to Lima and Kenya in December 2015; Testing to take place in 1st Qtr of 2016 Y2Q3: delay in testing 4th iteration due to time demanding other activities. Y2Q4: Testing of ClonDiag on-going in Lima; Reagents received for testing to begin in Muguga where will compare against grafting, NCM-Elisa, and PCR from Aug-Dec 2016 Yr3Qtr1: Successful test run of 4th iteration done in Kenya. **Y3Qtr2:** KEPHIS accreditation for virus indexing renewed on 14 Dec 2016 for one year. **Yr3**: 4th Iteration of ClonDiag received; Interlab testing done between CIP-Lima and CIP-KEPHIS. Sensitivity, specificity, repeatability and reproducibility tested, and data being analyzed in comparison with standard I. setosa grafting and testing. **Mid-Yr4:** Experiment comparing use of ClonDiag (21 viruses for $70) compared to grafting (10 viruses for $130) completed. Final comparisons of individual plantlets underway. Array tube reader and Smart Phone App improved & used in data analysis. **End Yr 4:** One more validation run, to be confirmed by next generation sequencing; Report due by 1st Sept 2018.	100	95	95
3.2.1	JK	Validated portable LAMP tool for detecting SPFMV & SPCSV	6	2016	Behind Schedule	5	2018	Yr1: New LAMP assays from FERA designed, we have started testing re-packaging with SPFMV and SPCSV assays; Assay working for SPFMV and East African strain of SPCSV Yr2: a new software, LAMP Designer 1.13, was purchased and installed at CIP-Nairobi and Lima to enable efficient (re-)design of LAMP primers for sweetpotato viruses. Can now field test in Lima and conducted trial to see how long key reagents could store. Y2Q3: storability of LAMP reagent in current form <6 months. New tests being performed to improve stability. Y2Q4: Delay in arrival of reagents in Nairobi; will test Aug-Dec 2016; need to test different stabilizers for reagents in kit. **Yr3Qt1:** Trial run for detecting SPCSV and SPFMV in lab and field trial in Kenya in Aug 2016 successful. Yr3: New LAMP assays from FERA designed testing for SPFMV and SPCSV assays	100	97	97

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								ongoing; Assay working for SPFMV and East African strain of SPCSV. Primers for Begomoviruses and SPCSV designed with LAMP Designer 1.13 software and ordered. Parameters for field test using LAMP optimized. This included sensitivity, specificity, repeatability and reproducibility. Stability of reagents at room temperature to be evaluated. **Mid-Yr4:** 1st version successfully field tested in October, but reagents had to be kept on ice. Now building in primers for Begomovirus as well. Will re-run experiment with improved assays and stable reagents. **End Yr4:** New primers ordered and will test in five field sites, with field work completed by mid-September. Report by 1st October.			
3.3.1	MM	At least three countries have draft standards and protocols for quality assurance of sweetpotato seed based on evidence	1	2019	On track			Y2 Q1: QDS write shop held in Ethiopia to capture lessons from development of seed standards, plan roll out and design study to assess where farmers benefit from QDS and inspection. Training of inspectors and roll out in progress in 4 regions (SNNPR, Amhara, Oromia, Tigray); Tanzania: QDS inspections continue in LZ (Kinga Marando project) involving TOSCI officials. Inspection protocol under review by TOSCI; Uganda: discussions on draft standards with stakeholders including MAAIF led by MAK, training for 3 districts planned for November; Rwanda, review of standards and training planned for November. Ghana, Nigeria, Burkina Faso: Jumpstarting project meeting will start to discuss way forward for using QDS standards. Mid Y2. Tz: Formal & QDS standards still waiting ministerial approval; Ug: training delayed; Rwanda: training postponed March 2016; Planning for: Nig, BF, Gh. Ethiopia: study of roll out will be conducted from June 2016. Y2Q3. QDS in Ethiopia in process of roll out. Tz still waiting ministerial approval. Uganda: training of inspectors in April 2016; Rwanda, 2 dialogue meetings with RAB and Rwanda Standards Board (RSB). RAB seed unit now officially requested RSB to prepare and submit standards. Zambia conducted annual training on seed standards; Mozambique, dialogue in process. Malawi, unofficial standards in use. EndY2: Uganda piloting July 2016; DARS Malawi submitted revised draft standards to Ministry for approval; Zambia will review after new Seed Act passed. Y3Q1: Rwanda (RSB) and Mozambique have draft standards for review; Ethiopia approved formal standards (PB, B, C). **Yr3Qtr2:** Tanzania seed standards gazetted	90	90	100

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								Feb17 co. Uganda: ready for publishing. Ethiopia study pending collaboration with RTB and PIM. EndY3: Nigeria drafted; Malawi trained inspectors in May 2017 but procedures still awaiting official approval; Kenya drafted. In Rwanda, standards still awaiting approval, but are in use in the field with positive feedback. In Ghana, QPDM standards printed; In Moz, stakeholder consultations on draft standards cont.; In Nigeria, stakeholder consultation to review final draft in May 2017; In Burkina Faso, draft submitted for approval. PIM-RTB-FTA study to review seed policy framework for VPCs will be piloted in Kenya end of June. **Mid-Yr4** 10 out of 11 countries (exception Zambia) now have drafted or revised SP seed standards. PIM-RTB-FTA study piloted in Kenya in July 17 and extended to Nigeria and Vietnam; this is now providing a broader platform to build evidence on common regulatory issues affecting VPCs; and stronger advocacy position for appropriate quality assurance mechanisms. CGIAR Gender Platform awarded additional (small) funds to deepen understanding gender dimensions and implications of current regulatory frameworks in Kenya for potato and sweetpotato. Need to plan write up of synthesis paper on experience with sweetpotato seed standards. **End Y4:** Rwanda, Mozambique and Zambia officially approved SP seed standards in this period.			
3.4	MM	Report on testing medium- to large-scale models for basic seed production	1	2019	On track			This is being started in Sept 2015 with the receipt of seed systems supplemental funding. Includes work in isolated rice schemes in Uganda. By June 2016, larger scale multipliers should have been identified & trained in Ug, Tz, Ethiopia Mid Y2: sites and medium scale multipliers identified in Ethiopia and Uganda; ongoing in Tanzania. Y2Q3: training and registration of cooperative on-going in Ethiopia; sites under selection in Tanzania in collaboration with SeFaMaCo, Fast Track; SP-Rice seed rotation study established in Agoro Irrigation scheme in N. Uganda. Rapid Seed Market Assessment underway in Agoro (May 2016). **Yr3Qtr2:** basic multipliers established and received bizskills training in Eth, Ug and Tz. Cost data collection in Tz. 2nd cycle of rotation study data in Agoro, Ug collected. **EndY3:** Uganda (Agoro): marketing strategy planned and implemented. Tanzania (LZ) marketing strategy under	80	80	90

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								implementation; Ethiopia 27 farmers registered as part of cooperatives and 3 Farmer Training Centers (FTCs) as missing middle operators. **MidY4:** Good progress in N. Uganda with basic multipliers earning over $6,000; LZ Tanzania & Ethiopia - ensuring stable market continues as key issue. Norman K leading study on CBA of the two major models comparing vine multiplication as a business in high virus pressure areas under protection; and low virus pressure areas under open field multiplication. **End Y4:** Agoro rice-SP-rice study completed, showing higher profitability of rotation compared to control. Norman K's study completed - providing evidence for focus on medium -to large scale multipliers, with larger protected structures. Multipliers in N. Uganda undertaken seed inspection training, review of business plans, and completing marketing strategies; Joint marketing strategy for Lake Zone multipliers with LZARDI, to increase awareness and strengthen linkages through the chain.			
4.1.1	DR/TS	Year-round supply of OFSP roots for a major urban market significantly improved	7	2017	Behind Schedule	12	2018	Yr1: Storage research linked to SUSTAIN projects in Kenya and Mozambique. Feasibility studies conducted in both countries. In Kenya, fresh roots will be linked to agro-processor of puree; In Mozambique, will target fresh root market. Yr2 Q1: harvesting and prestorage handling identified as having an important impact on root quality in Kenyan case study. Yr2 Qt2 Report of trials on impact of handling and transport in Western Kenya. Y2 Q1 Curing/holding facility created by upgrade of existing facility at puree processing plant in Kenya. Trials initiated to test efficacy of curing to improve mid-term (1 month) storage. Two larger scale longer-term trials have been initiated. Curing conditions can be effectively maintained, but technical problems have meant that the target temperature for subsequent storage have not been maintained and have highlighted the need for a robust system for identifying and solving equipment problems as they arise. Supply improvement has been delayed by delays in appropriate storage facility. **End Yr4:** Began handling/marketing study in informal and formal markets of Nairobi. Will conclude in August 2018.	100	90	90

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4.1.3	DR/TS	Improved techniques for larger-scale curing and storage appropriate for SSA developed & appropriate brochures/ briefs produced	7	2017	Behind Schedule	12	2018	Yr1: Private sector partner, Organi Ltd, identified in Kenya & short term holding facility constructed to improve the consistency of supply of OFSP roots to the processor. Protocols to improve handling of roots prior to storage developed. Y2 Q1 Curing/holding facility created by upgrade of existing facility at puree processing plant in Kenya. Trials initiated to test efficacy of curing to improve mid-term (1 month) storage. Y2 Q1 Curing/holding facility created by upgrade of existing facility at puree processing plant in Kenya. Trials initiated to test efficacy of curing to improve mid-term (1 month) storage. Two larger scale longer-term trials have been initiated. Curing conditions can be effectively maintained, but technical problems have meant that the target temperature for subsequent storage have not been maintained and have highlighted the need for a robust system for identifying and solving equipment problems as they arise. Yr3Qtr1: Testing improved evaporative cooling unit with simplified selection of curing or storing conditions. Q2 progress limited by delay in establishment of storage facilities. **Yr3Qtr2**: 1st three trials did not achieve objective; Re-worked storage facilities in July/Aug 2016; new trials started comparing solar and grid energy supply in Dec 2016, in Kenya but issues still exist with reaching desired temperature of 15^{o}C. Alternative approach using coolbot under design in Southern Africa. **Yr3:** Western Kenyan stores successfully constructed and tested capable of 4 months storage of roots providing sufficient quality for processing (70% of weight of roots retained). Further trials on storage technology ongoing. Handling trials delayed. In June 2017, built new storage facility in W. Kenya with solar-powered air cooling system that will be able to lower temperatures to 15 degrees C. Mid-**Yr4:** Trial established in solar-powered air-cooled container storage established in October 2017 cured roots at too high a temperature, leading to considerable rotting. Will be re-established in February 2018 after fixing problems due to rat attack on electrical system. **End-Yr4:** Completed 6th round of experiment in Kenya but had significant rot problem. May be due to excessive C02 accumulation. Trying to decide whether to repeat. Solar-powered storage container arrived in Mozambique on 6 June 2018.	100	90	90

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4.1.4	DR/TS	Improved techniques for fresh root harvesting, packaging, and transport & appropriate brochures/ briefs produced	1	2017	Behind Schedule	3	2018	Yr1: Trials initiated in Kenya on keeping qualities of different harvesting and root cleaning methods and packaging during transport. Y2 Qtr2: Trials in Ghana for long distance transport showed roots in tomato boxes suffered least damage; 2nd best were polypropylene sacks with ONLY 50 kgs roots; Yr2 Q1: harvesting and prestorage handling identified as having an important impact on root quality in Kenyan case study. Yr2 Qt2 Report of trials on impact of handling and transport in Western Kenya. Yr2 Qtr 2 Need to run more trials based on new knowledge. Yr2Qtr1: UDS preparing for next round of trial. **Yr3Qtr2**: UDS validation trials completed. 50 kg Polythene bag best container (current method uses extended bags) in Northern Ghana. Storage trial in Kenya testing washed vs unwashed roots Not much difference, if washed roots are briefly sun dried. Yr4: Brochure preparation for improved handling initiated. Trial for handling/marketing using crates or net bags to improve awareness and create demand began in June 2018.	100	85	85
4.2	TC	Report and brochures for improved methods for storing fresh roots for home consumption at HH level	12	2018	Almost Achieved			Yr1: Positive results from the double S or sandbox storage method tested in Ghana & Malawi Yr2 Qtr2: Brochure late being produced on root storage in sand; Sand box superior to moistened heaps (traditional practices in Ghana. Evaporative cooling trial started in January 2016. Q3 No progress; must wait for next harvest period Sept/Oct 2016 **Yr3Qt2:** Missed trial opportunity in Sept 2016; draft brochure on Double S prepared and revised in 2017. Mid-Yr4: Revised draft received of Double S brochure. **Yr4:** Revised draft received of Double S brochure. **End Yr4:** Double S brochure launched at April 2018 MPU meeting.	90	90	100

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4.3	TM	Report on viability of storing puree/ concentrate without a cold chain and the quality and safety of products made from stored puree vs fresh	6	2017	Almost Achieved	10	2018	Yr1: Protocol designed and first and second rounds of testing in progress. Vacuum packing with preservatives and citric acid very promising. YR2: Repeated testing of vacuum packing & natural vs chemical preservatives revealed 2 high potential solution for storage up to 6 months. Bread products with fresh puree have been analyzed for beta-carotene content but not yet with stored puree. We developed OFSP puree shelf-stable for 6 weeks at 20-23C with sorbate, benzoate and citric acid, and developed bread with it. The bread tastes good, but it takes long to proof. Yr3: Construction of storage facility just for Puree constructed and puree shelf-life now being tested. OFSP bread- HPLC analysis complete. 4 manuscripts and one guidebook in preparation. Volume of bread made with OFSP puree with preservatives now attains same volume as 100% wheat flour bread with increased yeast % and adding baking powder. Puree able to withstand microbial 'challenge" for 12 weeks at room temperature. OFSP bread quality best at storage temperatures not exceeding 25ºC. The preservative combinations of 1% citric acid, 0.25% potassium sorbate and 0.25% sodium benzoate together with vacuum packing and stored at temperatures below 24 Celsius can be stored for 3-4 months and used to make bread with a proofing time of 1 hour with 1.5% yeast and addition of 1% baking powder to actual the same bread volume at standard bread. Data on OFSP puree bread consumers collected from Tuskys. High fiber puree developed. Shelf stable OFS puree bread had long proofing time because of the sorbate, and citric acid. Adding baking soda at 1% neutralizes the citric acid. **Yr4:** Consumer acceptance studies conducted to determine the differences between fresh OFSP puree versus shelf-stable OFSP puree. Proximate analysis and physiochemical analysis comparing fresh OFSP puree products and shelf-stable puree products conducted with a University of Nairobi graduate student. In 2nd half: Student Wanjuu published paper of shelf-life of OFSP bread; Malavi on microbial contamination at purée factory and food Safety knowledge, attitudes, and practice at processing center and another student submitted for publication on OFSP puree challenge test to the International Journal of Food Science and Technology. PhD student Chilungo produced draft article looking at bioaccessibility of beta-carotene in different OFSP products.	98	98	100

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4.4	TM	Reference laboratory for nutritional quality & food safety in use	6	2019	On track			Yr1: Food Analysis and Nutrition Lab established in collaboration with BecA. Lab now has CIP Food Scientist and Lab technician; Supplies procured; 1st run of HPLC in January 2015; Microbial detection lab setup in progress. Yr2: HPCL fully functional for carotenoids, vitamin A, vitamin E and vitamin C. Microbial lab functional and doing total viable counts. Cost data collected, awaiting analysis. First 4-month intern from Cornell University assisted in food safety training. Identified Malawian student at NCSU to work on bioaccessibility in Yr3. Yr2Qtr3: The proximate analysis equipment is being installed, the phytonutrient protocol were tested, and second used HPLC from CIP HQ received in Sept 2016. We have two interns (Master's degree in Food Safety and Quality Management) from University of Nairobi working on OFSP puree storage, and OFSP bread consumer profiling studies. **Yr3:** Additional HPLC installed in Sept 2016 expanded analytic capacity. Bioaccessibility studies initiated. To date, 8 graduate students working within FANEL. A new graduate student identified to work on sensory panels for bread made with different formulations with shelf-stable OFSP puree. University of Nairobi collaborator Dr George Abong obtained ABCF fellowship from BecA to work on phytonutrient analysis of OFSP and in vitro glycemic index of OFSP products. Sarah Chilungo from NCSU working on bioaccessibility studies of beta-carotene from OFSP flour products and OFSP puree products. Derick Malavi, Cecilia Wanjuu and Joyce Musyoka submitted their masters' theses in June and graduated in 2017. Mercy another graduate student from UoN will start survey of OFSP nutrition in children in western Kenya. Proximate and beta-carotene analysis of OFSP puree bread conducted at different levels of puree substitution. 4 baked OFSP products for Rwanda analyzed for beta-carotene and proximate analysis conducted. Proximate analysis of OFSP puree bread underway and also OFSP puree from storage trials samples of puree and fresh roots. Protocols developed for transgenic potato for simple sugars, vitamin C and glycoalkaloids. These protocols were also adapted for sweetpotato. Food Scientist Muzhingi awarded Emerging Leaders Network Award by the Institute of Food Technology in July 2018. Derrick Malavi will become new lab manager in August 2018.	70	70	100

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5.1.1	JL	Minutes of annual breeding meetings highlight progress being made in capacity building and info sharing	Jul	2019	On track			Yr1: Meeting held 2-5 June 2015 in Mukono, Uganda. Yr2: Meeting held 6-10 June 2016 in Nairobi, Kenya. Minutes available as milestone reports. Updated breeding progress paper submitted to APA meeting in October 2016. **Yr3:** Annual meeting 15-18 May 2017 in Kigali and minutes produced. **Yr4:** 2018 meeting held in Nairobi, 5-8 June and minutes produced. Specialized internal training on analyzing breeding data held in Kumasi Ghana in January 2018.	65	65	100
5.1.2	JL	Presentations of SPHI meeting & evaluation of its usefulness	Jul	2019	On track			Yr1: Phase 2 financed September 2014 annual meeting. Minutes available as milestone report. Presentations posted on renovated Sweetpotato Knowledge Portal. Yr2: 6th Annual meeting held in Kigali, Rwanda. **Yr3:** 7th Annual meeting held Addis Ababa, Ethiopia. Minutes for Yr3 and evaluation completed. **Yr4:** 8th Annual meeting held in Dar-es-Salaam, Tanzania along with exhibition and field trips. Report of SPHI minutes, SPHI Steering Committee and PAC minutes completed. .	80	80	100
5.1.3	JL in coordination with CoP leaders	Presentations and minutes of CoP meetings	Jul	2019	On track			Yr1: Minutes available for meetings held: Monitoring, Learning and Evaluation (3-4 March 2015); Seed Systems & Crop Management (28-29 April 2015) and Marketing, Processing and Utilization (20-21 May 2015); Breeding & Genomics (2-5 June 2015); Yr2: Seed Systems- Pre-basic Seed (8-10 December 2015); Marketing, Processing and Utilization (14-16 March); Monitoring, Learning and Evaluation (27-29 April); Seed Systems and Crop Management (9-12 May) in Arusha; **Yr3:** 2nd Seed System meeting just for pre-basic seed system sub-grantees held in Nairobi (6-8 December 2016); MLE meeting in Maputo (30 January-2 February 2017); MPU meeting in Kisumu, Kenya (2-3 March 2017); Seed Systems Pre-Basic sub-group and CoP meeting in Mukono, Uganda (12-14 June 2017).**Yr4:** Seed Systems Pre-basic Sub-Grantees CoP meeting held in Nairobi, Kenya (20-22 November). MLE meeting held in Nairobi with additional training in STATA statistical package (12-18 March 2018). MPU meeting held in Blantyre, Malawi (23-24 April) with additional Investment Forum day (25th April). Major Seed systems meeting held in Kigali, Rwanda (15-17 May), with a one-day meeting held for the sub-grant recipients on institutionalizing pre-basic seed production (14 May).	70	70	100

Milestone #	Responsible	Key Milestones	Due Date		Current Status	Revised Date		Comment Concerning Current Status	Planned % of Milestone as of 1 July 2018	% Progress of Milestone as of 1 July 2018	% Progress/ Planned July 2018
			Mon	Year		Mon	Year		Y4	Annual	
5.1.4	JO	Database on dissemination efforts updated annually & use of SKP monitored	Jul	2019	On track			Yr1: Tested monitoring with smart phones in collaboration with Nigeria project; Began mapping decentralized vine multipliers in each country; Embarked on Knowledge Portal re-design with Netmidas. 1st Sweetpotato in SSA update report prepared for SPHI Steering Committee Meeting held 2nd October 2015 in Kigali; 2nd update presented in Addis Ababa in October 2016. Renovated Knowledge Portal relaunched in February 2016. Monthly E-Digest of highlights from Knowledge Portal started in May 2016. **Yr3:** Contact list for SSA still being updated. New Kenyan company hired to fix remaining Knowledge Portal problems in Dec 2016. Expected to finish by 15 July 2017. **Yr4:** 3rd Sweetpotato in SSA update report presented at SPHI Technical meeting and discussed in SSC; Work on renovating Knowledge Portal completed. Dashboard for key dissemination, varietal release and DVM access completed. Monthly monitoring of social media hits (Facebook twitter) began in March 2018. New section on detailed sweetpotato recipes added June 2018. For 1st time, had mid-year dissemination update for period July-Dec 2017.	70	70	100

APPENDIX B. SASHA2 YEAR 4 ANNUAL DETAILED BUDGET AND EXPENDITURES

Sweetpotato Action for Security and Health in Africa (SASHA): Phase 2
Organization Name: International Potato Centre (CIP)
Financial Year: 2017/2018 : Y4_Financial_Report_as_of_June 30, 2018

Budget Line Items	Year 1: Expenses	Year 2: Expenses	Year 3: Expenses	Y1 - Y3: Total Expenses	Y4: Budget	Y4: Expenses	Y4: Balance	% Spent	Total Expenditures
	USD	USD	USD	USD		USD	USD	USD	USD
Total Personnel	1,459,545	1,585,841	1,721,662	4,767,047	1,974,445	1,827,346	147,099	93%	6,594,393
Breeding	752,313	759,684	712,766	2,224,763	941,444	959,256	(17,812)	102%	3,184,019
Weevil Resistance using Transgenics	178,206	60,958	31,985	271,148	-	-	-	0%	271,148
Seed Systems	176,782	216,427	310,769	703,977	347,946	320,291	27,655	92%	1,024,268
Postharvest management and nutritional quality	26,463	36,887	80,862	144,213	73,912	62,911	11,001	85%	207,124
Governance	325,781	511,885	585,280	1,422,946	611,143	484,888	126,255	79%	1,907,834
Total Travel	373,832	569,595	507,584	1,451,011	412,561	404,317	8,244	98%	1,855,328
Breeding	133,976	189,320	169,912	493,208	182,992	204,247	(21,255)	112%	697,456
Weevil Resistance using Transgenics	20,428	3,787	288	24,503	-	-	-	0%	24,503
Seed Systems	35,991	94,401	115,862	246,255	69,569	47,190	22,379	68%	293,445
Postharvest management and nutritional quality	6,409	18,780	13,215	38,404	-	(0)	0	0%	38,404
Governance	177,028	263,306	208,307	648,641	160,000	152,880	7,120	96%	801,521
Total Sub-grants to Others Organizations	463,696	628,429	507,972	1,600,097	531,279	432,419	98,860	81%	2,032,515
Breeding	33,077	54,437	70,634	158,147	167,250	103,863	63,387	62%	262,010
Weevil Resistance using Transgenics	190,311	-	-	190,311	-	-	-	0%	190,311
Seed Systems	69,642	371,996	373,275	814,913	295,132	270,463	24,669	92%	1,085,375
Postharvest management and nutritional quality	170,666	201,997	64,063	436,726	68,897	58,093	10,804	84%	494,819
Governance	-	-		-	-	-	-	0%	-
Total Equipment	138,289	84,797	46,118	269,204	60,315	25,992	34,323	43%	295,196
Breeding	62,133	59,524	6,199	127,856	36,000	16,099	19,901	45%	143,955
Weevil Resistance using Transgenics	-	-	-	-	-	-	-	0%	-
Seed Systems	34,806	-	14,245	49,051	-	-	-	0%	49,051
Postharvest management and nutritional quality	41,350	25,273	25,674	92,297	24,315	9,894	14,421	41%	102,191
Governance	-	-	-	-	-	-	-	0%	-
Consulting	-	45,494	30,035	75,529	62,000	35,101	26,899	57%	110,630
Breeding		15,904	-	15,904	9,000	-	9,000	0%	15,904
Weevil Resistance using Transgenics		-	-	-	-	-	-	0%	-
Seed Systems		21,500	19,843	41,343	28,000	32,983	(4,983)	118%	74,326
Postharvest management and nutritional quality		-	-	-	25,000	2,119	22,881	0%	2,119
Governance		8,090	10,192	18,282	-	-	-	0%	18,282
Other Direct Costs	769,978	1,044,293	998,579	2,812,850	1,147,788	1,075,672	72,116	94%	3,888,522
Breeding	510,576	668,583	482,858	1,662,017	544,632	599,749	(55,116)	110%	2,261,766
Weevil Resistance using Transgenics	58,830	41,121	44,232	144,183	-	-	-	0%	144,183
Seed Systems	96,757	148,772	216,218	461,748	326,935	198,221	128,714	61%	659,969
Postharvest management and nutritional quality	29,624	88,684	86,421	204,729	55,000	57,247	(2,247)	104%	261,976
Governance	74,191	97,133	168,850	340,173	221,221	220,456	765	100%	560,629
Total Direct Costs	3,205,339	3,958,449	3,811,950	10,975,737	4,188,388	3,800,848	387,540	91%	14,776,585
Total Indirect Costs	480,801	590,821	571,792	1,643,414	628,258	570,127	58,131	91%	2,213,541
Grand Total Costs	3,686,139	4,549,269	4,383,742	12,619,151	4,816,646	4,370,975	445,671	91%	16,990,126

Summary	Year 1 : Expenses	Year 2: Expenses	Year 3: Expenses	Total Expenditures	Y4: Budget	Y4: Expenses	Y4: Balance	% Spent	Grand Total
	USD	USD				USD	USD	USD	USD
Total CIP Direct costs	2,741,643	3,330,019	3,303,978	9,375,640	3,657,109	3,368,429	288,680	92%	12,744,070
Total indirect costs	480,801	590,821	571,792	1,643,414	628,258	570,127	58,131	91%	2,213,541
Total Subgrantees	463,696	628,429	507,972	1,600,097	531,279	432,419	98,860	81%	2,032,515
Grand totals	3,686,139	4,549,269	4,383,742	12,619,151	4,816,646	4,370,975	445,671	91%	16,990,126

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