FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Integrating Agriculture, Nutrition, and Marketing with Biofortified Orange-fleshed Sweetpotato (OFSP)

The VISTA–Tanzania Experience: Evidence of Change and Major Lessons Learned

END OF PROJECT FINAL REPORT

1 October 2014–31 December 2017

USAID
FROM THE AMERICAN PEOPLE

CIP
INTERNATIONAL POTATO CENTER
A CGIAR RESEARCH CENTER

INTEGRATING AGRICULTURE, NUTRITION, AND MARKETING WITH BIOFORTIFIED ORANGE-FLESHED SWEETPOTATO (OFSP)

THE VISTA–TANZANIA EXPERIENCE: EVIDENCE OF CHANGE AND MAJOR LESSONS LEARNED

END OF PROJECT FINAL REPORT

1 October 2014–31 December 2017

17 May 2018

Contract No: 1236-USAID

Principal Author: Frederick Grant

Project Name: Feed the Future Tanzania Viable Sweetpotato Technologies in Africa (VISTA)

Reporting Period: 1 October 2014–31 December 2017

Project Duration: 3 years

Contact Information:

International Potato Center–Tanzania

P.O. Box 2473 Morogoro, Tanzania

Tel: +255 759 184 827

CONTENTS

Acronyms ..... **ii**

Executive Summary ..... **iii**

1. VISTA–Tanzania Project Overview **1**

1.1 Introduction 1

1.2 Implementation AApproach 2

1.3 Project Objectives 4

2. Delivering on Project Objectives and Outcomes: Results from VISTA M&E Activities **5**

2.1 Summary of Achievements 7

2.2 Summary of Project Outcomes 8

3. Understanding Gender and Market Context **9**

3.1 Findings of the Gender Formative Study 9

3.2 Results of the Rapid Market Assessment 11

4. Evidence of Change: Findings of the Outcome Evaluation Survey **11**

4.1 Project Sample Description 12

4.2 Changes in Household and Young Child Dietary Diversity 13

4.3 Changes in Household Food Security 17

4.4 Farmer Technology Exposure and Uptake 21

5. Integrated Agriculture–Nutrition Programming: Lessons Learned **22**

5.1 Project Design and M&E 22

5.2 Integration with Government Systems 23

5.3 Integration with Market Systems 24

6. Conclusion **25**

References **26**

Appendices **28**

Appendix 1: Counselling Card (Kiswahili Version) Used by CHWs in the Monthly Nutrition Club Meetings 28

Appendix 2: Survey Methodology 29

Appendix 3: Questionnaire for the Endline Survey Data Collection 36

ACRONYMS

ARI	Agriculture research institute
CAPI	Computer-Assisted Personal Interviewing
CHWs	Community health workers
CIP	International Potato Center
DVMs	Decentralized vine multipliers
HFIAP	Household food insecurity access prevalence
HFIAS	Household Food Insecurity Access Scale
HH	Household
IQR	Inter-quartile range
LGA	Local government authority
M&E	Monitoring and evaluation
NGO	Nongovernmental organization
OFSP	Orange-fleshed sweetpotato
PCA	Principal component analysis
SBCC	Social and behavior change communication
SP	Sweetpotato
SREs	Seed and root entrepreneurs
SRI	Sugarcane Research Institute
SES	Socioeconomic status
ToTs	Training of trainers
USAID	United States Agency for International Development
VAD	Vitamin A deficiency
VAEO	Village agricultural extension officer
VISTA	Viable Sweetpotato Technologies in Africa
W/VAEO	Ward and village agricultural extension officers
ZOI	Zones of Influence

EXECUTIVE SUMMARY

The Feed the Future Viable Sweetpotato Technologies in Africa (VISTA) Tanzania project, designed and implemented by the International Potato Center (CIP) and its partners[1] from 2014 to 2017, set out to contribute to improved nutrition, food security, and incomes in rural Tanzania by expanding the production and utilization of nutritious orange-fleshed sweetpotato (OFSP) in seven districts in Mbeya, Iringa, and Morogoro regions, part of Feed the Future's Zones of Influence. Using proven implementation approaches from related projects that combine agricultural, nutrition, and marketing interventions, VISTA's goal was to extend the production, consumption, and marketing of OFSP products among 21,000 smallholder farmers with children under 5 years and 20 medium-sized farmers. Of these, 17,500 households (HH) were to participate in a fully integrated agriculture–nutrition intervention package, and 28 entrepreneurs were to be supported to become financially viable sweetpotato seed and root enterprises (SREs). USAID–Tanzania financed the project through a $3,125,000 grant.

VISTA–Tanzania pursued the following four specific objectives and outputs:

- Objective 1: Increased production and consumption of nutritious OFSP varieties through an integrated agriculture–nutrition technology set

  Output 1.1: Agro-ecologically adapted OFSP varieties with market attributes available for uptake by root producers.

  This output was delivered through Mother–Baby trials conducted by the project's national partner, the Sugarcane Research Institute (SRI)–Kibaha and the agriucltural research institute (ARI)–Uyole. It was recommended that out of the 11 OFSP clones tested for 2 years under different agro-ecological zones of Tanzania, 8 clones be moved to the next phases of the varietal release process: (1) distinctiveness, uniformity, and stability and (2) national performance trials.

  Output 1.2: Entrepreneurs establish financially sustainable medium-scale SREs linked to upstream source of quality pre-basic OFSP planting material and downstream to individuals and community groups demanding planting material.

  This output was delivered through the establishment of 30 viable SREs in the seven project intervention districts.

  Output 1.3: Smallholder and medium-scale farmers grow OFSP and realize increased productivity through accessing quality planting material and applying improved agronomic practices.

  This output was delivered by the established SREs under output 1.2.

- Objective 2: Improved nutrition knowledge and practices

  Output 2.1: Households receive social and behavior change communication (SBCC), including knowledge on OFSP utilization and consumption.

  Output delivered as planned with 21,876 primary caregivers of children under 5 from smallholder farm HH receiving SBCC through monthly nutrition group meetings.

  Output 2.2: Staff from target districts trained in improved nutrition counseling.

[1] The project was implemented in partnership with Sokoine University of Agriculture; SRI–Kibaha; ARI–Uyole; Farm Concern International; local government agriculture and health/nutrition district extension offices in the Mbeya, Iringa, and Morogoro regions; and a local nongovernmental organization based in Wanging'ombe District: Njombe Agriculture Development Organization.

Output delivered with 831 community leaders, including community health workers (CHWs), trained (and refresher-trained) on improved nutrition counseling.

Output 2.3: Various nutrition messages and counseling, including on vitamin A-rich foods and OFSP, implemented in target districts.

Output delivered with eight different nutrition counseling messages, including on vitamin A-rich foods and OFSP, in the counseling cards used for training community leaders and stepped down to caregivers from beneficiary HH.

- Objective 3: Root producers and traders use improved storage and marketing of fresh OFSP roots

  Output 3.1: Technologies for improved storage and marketing practices of fresh roots disseminated.

  Output delivered through the implementation of adaptive storage technologies for OFSP roots in all seven intervention districts.

  Output 3.2: Selected fresh OFSP root market chains improved.

  Output delivered through establishment of SREs who were introduced to various market chains by the project implementation partner, Farm Concern International.

- Objective 4: Improved evidence-based and policy support for OFSP production and utilization

  Output 4.1: Staff from government of Tanzania and nongovernmental organizations (NGOs) trained in sweetpotato (SP) training of trainers (ToTs).

  Output delivered through training of 674 community and NGO agriculture and health/nutrition officers on OFSP production agronomy and utilization (including nutrition) through the ToTs course "Everything you ever wanted to know about sweetpotato."

  Output 4.2: Evidence for OFSP production and nutrition support in target districts strengthened.

  Output delivered through increased production of OFSP root (792 ha) and establishment of 140 nutrition clubs in all seven intervention districts.

  Output 4.3: Learning events for stakeholders at district and national levels conducted.

  Output delivered through various field days held in all seven intervention districts that were attended by various stakeholders in the sweetpotato value chain.

To monitor and assess the project's effectiveness in achieving these objectives, the VISTA monitoring and evaluation strategy included regular community-level monitoring as well as a two-round cross-sectional household survey of 512 target beneficiary HH. The baseline survey was conducted from September to December 2015, and the endline survey from August to October 2017. In addition, a qualitative formative gender evaluation study was used to assess the influence of gender on the project's implementation. A rapid market assessment study was carried out to determine the commercial potential of OFSP in the project intervention areas and beyond. Finally, a Mother–Baby trial involving 11 clones and five varieties was carried out in seven selected sites of three agro-ecological zones of eastern and southern highlands of Tanzania.

Evidence generated through these surveys and studies suggests that VISTA–Tanzania generally resulted in increased production and consumption of nutritious OFSP; significantly increased caregiver knowledge on vitamin A, nutrition, health-seeking, and childcare; and significantly improved dietary vitamin A intake, dietary diversity, and food security among beneficiary HH. Specific key changes that can be attributed to VISTA are presented below.

Production and food security:

- OFSP became the preferred choice of SP type for many HH after 3 years of project intervention, with 42% of the respondents producing OFSP by 2017. This contrasts with baseline data when SP was dominated by white-fleshed (73%) and yellow-fleshed varieties (26%), with OFSP at 0.8%. By the end of the project, the cultivation incidence of white- and yellow-fleshed varieties had declined to 33% and 25%, respectively.
- HH food security improved between baseline and endline studies, with HH categorized as having "high" food insecurity being reduced from 34% at baseline to 16% by the endline survey.

Dietary changes:

- Forty-six percent of the HH consumed OFSP in the past 24 hours before the endline survey, with 42% of the reference children also consuming OFSP. This contrasted sharply with the baseline study, when only 0.4% of HH had consumed OFSP 24 hours before the survey interview.
- HH nutrition knowledge in general, and vitamin A knowledge in particular, among caregivers increased by 63% between baseline to endline surveys. Further, the average health- and childcare-knowledge score of caregivers at endline improved by 27% compared with baseline.
- HH dietary diversity increased by 72% between baseline and endline, whereas young child dietary diversity increased by 18% at endline.
- The consumption of vitamin A-rich foods increased by 63% between baseline and endline. These improvements could be attributed to project nutrition activities at the village run by CHWs.

VISTA–Tanzania took a deliberate "results-based management" approach and carefully documented and analyzed the planning, implementing, and evaluating process. This has enabled CIP and partners to extract lessons and recommendations for future multisectoral program design. Some of the main lessons are:

- To support the design and stakeholder ownership of innovative approaches, a thorough diagnosis of institutional and market systems is instrumental. Substantial time is needed for the diagnostic phase and redesigning the implementation activities based on findings from that phase.
- Thinking through the program theory of change and updating the impact pathway or logical framework can ensure integration of the various sectors and disciplines. It can provide guidance for appropriate combination of both qualitative and quantitative monitoring.
- Because of the multisectoral nature of such interventions, multiple evaluation components may be required to respond to the different models and disciplines of evidence present in the different sectors.
- Integration across the multiple sectors required substantial coordination, networking, and organizational and local government authority support.
- There is need for integrated cross-discipline trainings (and refresher trainings) (e.g., on agriculture, nutrition/health, marketing, gender integration, and data management) for the various implementing partners to ensure that all key stakeholders adequately understood all components of the intervention.
- Regular quarterly partners' meetings for the implementation team and broader network of stakeholders of the project were necessary to continuously review, plan, and update key stakeholders of the project progress. This emphasizes the importance of allocating sufficient resources to critical organizational and management meetings that are essential for supporting integrated approaches to have sustainable impact.

- Community-level implementing staff such as ward and village agricultural extension officers and CHWs was critical to the success of the project.
- Establishment and training of community-based vine multipliers or decentralized vine multipliers and SREs are critical to ensure adequate availability of clean source of planting materials for downstream uptake by farmers and other root producers.

VISTA–Tanzania was effective in integrating OFSP into local farming and food systems and thus achieved its goal. There were improvements in food security and diet quality at HH level and among young children. Significant changes were observed in OFSP production and farming from baseline to endline among intervention HH with children under 5. The positive agricultural and nutrition outcomes documented throughout the intervention periods came about because HH members had been empowered to adopt OFSP technologies and management practices. Evidence abounds that the project approach adopted was potentially conducive to longer term sustainability due to the high-level of buy-in and engagement it encouraged from the onset, particularly in terms of its capacity to mobilize community members and engage with key stakeholders.

1. VISTA–TANZANIA PROJECT OVERVIEW

1.1 Introduction

Vitamin A deficiency (VAD) contributes significantly to human blindness, reduced disease immunity, and premature death in sub-Saharan Africa. Young children and pregnant or breastfeeding women are particularly at risk of VAD [1,2]. Among young children, VAD results in regular child morbidity, poor vision development, and child and maternal mortality [1]. In Tanzania more than one-third (33%) of children aged 6–59 months and 37% of women aged 15–49 years are estimated to be vitamin A deficient [3]. Pregnant women have a higher prevalence of VAD (39%); its prevalence among women is higher in urban areas than in rural areas (40% and 36%, respectively). According to the 2016 Tanzania Health and Demographic Survey [4], the prevalence of stunting, underweight, and wasting among children aged 0–59 months is 34%, 14%, and 5%, respectively [3]. At the global level, the global hunger index for Tanzania in 2017 was 28.8, placing it at 97 among 119 countries [5]. The index integrates percent of the population that fails to get adequate calories in the diet, child mortality, child stunting, and child wasting for a given country [4]. Given the important role of agriculture as the main source of both food and income for the smallholder farming HH in Tanzania, nutrition-sensitive agricultural development as a multisectoral approach is imperative for addressing poor child malnutrition in particular and improved HH-feeding in general.

Food-based efforts are highly complementary to other approaches in tackling VAD such as capsule supplementation and food fortification, especially for rural communities where alternative interventions have greater difficulty to consistently and sustainably reach beneficiary population in a timely manner. Orange-fleshed sweetpotato (OFSP) varieties that have high vitamin A content stand out as a proven and cost-effective intervention to reduce VAD and provide energy and additional vital nutrients to vulnerable population groups. The efficacy of OFSP to combat VAD is based on the high concentration of pro-vitamin A in roots and leaves with high levels of bioaccessibility in local diets[2]. This nutritional benefit of OFSP can be exploited by integrating sweetpotato (SP) cultivation with nutrition education, counseling, and advocacy for primary child caregivers, farmers, communities, agricultural extension experts, and policymakers to appreciate and recognize the importance of OFSP to improve human nutrition, especially early in life[3].

The Feed the Future Viable Sweetpotato Technologies in Africa (VISTA) Tanzania project, funded by USAID–Tanzania, was a 3-year initiative executed by the International Potato Center (CIP) and its partners in Tanzania. It was designed to expand the production and utilization of the nutritious OFSP into seven districts in Mbeya, Iringa, and Morogoro regions, which form part of Feed the Future's Zones of Influence (ZOI), namely Gairo and Ulanga districts in Morogoro Region, Mufindi and Iringa districts in Iringa Region; and Wanging'ombe, Chunya, and Mbozi districts in Mbeya Region. Morogoro Region falls in the Eastern Highlands and Iringa and Mbeya regions are in the Southern Highlands agro-ecological zones. Both agro-ecological zones receive the highest annual rainfall in Tanzania; both are home to major water bodies which

---

[2] van Jaarsveld, P. J., M. Faber, S. A. Tannumihardjo, P. Nestel, J. C. Lombard, and A. J. S. Benade. 2005. *ß*-Carotene-Rich Orange Fleshed Sweet Potatoes Improve the Vitamin A Status of Primary School Children Assessed with the Modified-Relative-Dose-Response Test. *American Journal of Clinical Nutrition* 81(5):1080–1087.

Hotz, C., Loechl, C., de Brauw A., Eozenou, P., Gilligan, D., Moursi, M., Munhaua, B., van Jaarsveld, P., Carriquiry, A., and Meenakshi, J. V. 2011. A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. *Br J Nutr.* Oct. 10:1–14.

[3] Low, J., M. Arimond, N. Osman, B. Cunguara, B. Zano, and D. Tschirley. 2007. A Food-Based Approach Introducing Orange-Fleshed Sweet Potatoes Increased Vitamin A Intake and Serum Retinol Concentrations in Young Children in Rural Mozambique. *The Journal of Nutrition* 137(5):1320–1327.

influence the eco-climate while the numerous rivers are used for many small-scale irrigation schemes. Maize, cassava, rice, potato, and SP are the main staple crops grown. The rearing of cattle, small ruminants, and poultry is widely practiced. SP is produced mainly for home consumption and is eaten as boiled, roasted, or deep-fried storage roots. However, SP leaves in Tanzania are also consumed in local diets as common green leafy vegetable in rural and urban markets.

At the beginning of the project in 2015, there were no documented data on the proportion of HH consuming OFSP to our knowledge, which would have been very important for our work in the project target district as a benchmark. However, the project baseline survey revealed that only 0.4% of the HH consumed OFSP 24 hours before the survey interview [15]. Caregiver knowledge on nutrition in general and vitamin A in particular was poor among the participants. Overall, only about 20% had adequate knowledge of vitamin A, mostly from health units, school, and community health workers (CHWs). There was very low consumption of vitamin A-rich foods by caregivers and children aged 6–59 months. The overall consumption of vitamin A-rich foods for HH at the recommended 6 days/week was only 16%. The consumption of OFSP was reported in 0.4% of the surveyed HH. On average, SP production was reported at 0.6 acres/farm family and was dominated by white-fleshed (73%) and yellow-fleshed (26%) varieties. OFSP varieties in 2015 were grown in only 0.8% of the surveyed farm families. Appendix 2 discusses the survey in more detail.

1.2 Implementation Approach

The VISTA–Tanzania project was implemented from 1 October 2014 to 31 December 2017 in rural communities through a community-based strategy targeting farmer HH with children under 5. Specifically, VISTA–Tanzania used agriculture extension officers from the seven intervention districts to select eligible HH from villages that traditionally grow SP. From each district about 25 villages were selected and approximately 3,000 HH that met the inclusion criteria were included as project beneficiaries. Through the use of the district-level local government authority (LGA) team and village agriculture extension officers (VAEOs), each HH was initially supplied with 100 cuttings of clean OFSP planting materials or vines of any of the five varieties ('Kabode', 'Ejumula', 'Kakamega', 'Mataya', and 'Kiegeya') that were promoted by the project. Follow-up distribution of planting materials to these HH were carried out during the second and third year of the intervention. This ensured that each eligible HH received at least 300 vine cuttings of the OFSP varieties by the end of the project.

In addition, step-down trainings at the community level were conducted by 674 community and nongovernmental organization (NGO) agriculture and health/nutrition officers. In training of trainers (ToTs), trainers had earlier been trained on OFSP production agronomy and nutrition and had adequate capacity to deliver the information and technologies. The course content focused mainly on OFSP production and utilization (including OFSP nutrition and vitamin A). The step-down trainings were very practical in nature, with beneficiaries visiting demo plots in practical sessions during which SP production was demonstrated. From these trainings, HH members were trained to initially bulk the planting materials received (300 cuttings) to approximately 1,800 cuttings, sufficient to plant about 0.05 ha (500 m^2) of OFSP root production, which was enough to meet the annual dietary vitamin A requirements of five HH members.

With the assistance of the district nutrition officers, the project selected and trained CHWs from each of the intervention villages in the district. The CHWs were trained in nutrition education and counseling as well as appropriate practices on maternal, infant, and young child feeding during the first 1,000 days of baby's life. The trained CHWs established and ran community-level pregnant and breast-feeding women's clubs with monthly counseling meetings that were attended by primary caregivers of children under 5.

The project also identified decentralized vine multipliers (DVMs) to support and broaden production of disease-free vines that were distributed to other HH. Similarly, seed and root entrepreneurs (SREs) were engaged, trained, and supported to establish "secondary" multiplication sites on a cost-share basis, with at least four SP enterprises servicing the needs of each target district. Thirty SREs were selected and trained (and refresher trained) on agri-business and SP agronomy for 2 years. In business training, they received various trainings on business planning, enterprise viability/economic analysis, financial access, and supply chain coordination and management. All this formed part of their development in agri-business or agri-entrepreneurship. In agronomy, they received trainings on sweetpotato (OFSP) agronomy and dry-season seed conservation of OFSP planting material, Triple S (storage in sand and sprouting), and net tunnel technology. The SREs were able to establish financially sustainable medium-scale seed (and root) enterprises which were linked upstream to source of quality pre-basic OFSP planting material and downstream to individuals and community groups demanding planting material.

Project activities at village level were monitored by trained VAEOs, who monitored the beneficiaries in their homes, provided agronomic advice, and discussed OFSP planting and crop management. The project included a start-up diagnostic phase, an inception phase, an implementation phase beginning in mid-2015, with recurrent activities from June 2015 through August 2017. For the implementation phase vines were distributed from August 2015 to August 2017.

The project diagnostic phase was undertaken during the first 6 months of the project. This enabled project management to identify and contract appropriate partners and stakeholders to be part of the project implementation plan; streamline partners' roles and responsibilities; and conduct target project area rapid appraisals to identify locations, technologies, stakeholders, partners, and varieties of OFSP available in the proposed project intervention districts. This helped to adjust project work plans and budget and to design interventions with partners based on results of diagnostic appraisals. Figure 1 provides a timeline of the key activities.

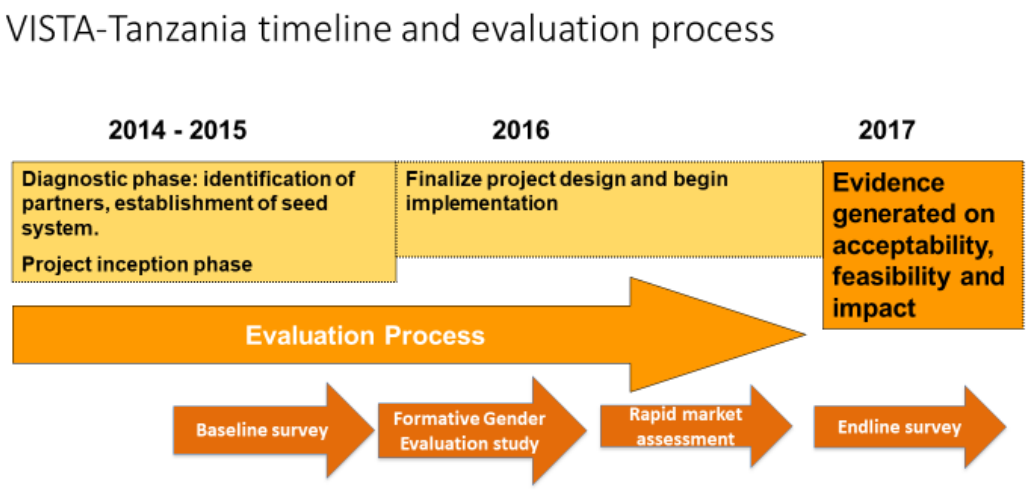

Figure 1. Timeline of the VISTA–Tanzania project's planning, implementation, and evaluation.

The project developed information, education, and communication materials for use by CHWs and VAEOs. Among these materials was a desk-sized (A3 format) set of counseling cards with eight lessons that were adopted from other CIP projects. Each page on the chart had illustrated examples on the front, with the accompanying messages on the back with four or five key messages per topic. The major topics were (1) healthy mothers during pregnancy; (2) healthy eating; (3) vitamin A; (4) biofortification; (5) infant feeding; (6)

OFSP benefits; (7) growing OFSP; and (8) creating a kitchen garden and planting fruit trees (see Appendix 1). The CHWs were provided with the cards for conducting monthly breast-feeding and pregnant women's club sessions that covered additional topics such as breastfeeding and care during illness. HH who received OFSP planting materials from VAEOs were also provided with a brochure that described (1) planting, caring, and harvesting of sweetpotato (OFSP), including how to avoid the crop being infested by the sweetpotato weevil; (2) vitamin A sources, uses, and benefits; (3) infant and young child feeding; and (4) OFSP benefits and uses. The benefits of producing and consuming OFSP were conveyed to the larger community through semi-annual field days that highlighted the new varieties, methods for preparing OFSP, and business opportunities for the commercial production of OFSP.

1.3 Project Objectives

The overall goal of the VISTA–Tanzania project was to contribute to improved dietary diversity, food security, and incomes in Tanzania, especially among farmer HH with children under 5. The purpose of the project was to extend the production, consumption, and marketing of OFSP products among 21,000 smallholder farmers and at least 20 medium-scale farmers in seven districts within the Feed the Future Tanzania ZOI. The specific objectives and outputs were:

- Objective 1: Increased production and consumption of nutritious OFSP varieties through an integrated agriculture-nutrition technology set

  Output 1.1: Agro-ecologically adapted OFSP varieties with market attributes available for uptake by root producers.

  Output 1.2: Entrepreneurs establish financially sustainable medium-scale SREs linked to upstream source of quality pre-basic OFSP planting material and downstream to individuals and community groups demanding planting material.

  Output 1.3: Smallholder and medium-scale farmers grow OFSP and realize increased productivity through accessing quality planting material and applying improved agronomic practices.

- Objective 2: Improved nutrition knowledge and practices

  Output 2.1: Households receive social and behavior change communication (SBCC), including knowledge on OFSP utilization and consumption.

  Output 2.2: Staff from target districts trained in improved nutrition counseling.

  Output 2.3: Various nutrition messages and counseling implemented in target districts including vitamin A-rich foods and OFSP.

- Objective 3: Root producers and traders use improved storage and marketing of fresh OFSP roots

  Output 3.1: Technologies for improved storage and marketing practices of fresh roots disseminated.

  Output 3.2: Selected fresh OFSP root market chains improved.

- Objective 4: Improved evidence based and policy support for OFSP production and utilization

  Output 4.1: Staff from government of Tanzania and NGOs trained in SP training of trainers.

  Output 4.2: Evidence for OFSP production and nutrition support in target districts strengthened.

  Output 4.3: Learning events for stakeholders at district and national levels conducted.

2. DELIVERING ON PROJECT OBJECTIVES AND OUTCOMES: RESULTS FROM VISTA M&E ACTIVITIES

The monitoring and evaluation (M&E) strategy of VISTA–Tanzania was designed to assess the feasibility, acceptability, impact, and hence overall effectiveness and sustainability of the OFSP delivery strategy linked to nutrition behavior change and communication at the community level. Table 1 provides the project outcome logic and outlines the key processes through which the project operates and provides the framework for M&E.

The project used three main sets of activities to monitor and evaluate key project outputs and outcomes. First, to assess project implementation and measure outputs, beneficiary communities (e.g., tracking pregnant and breast-feeding women's clubs and numbers of women per club session) and the type of messages delivered at the monthly club meetings, including cooking demos, were regularly monitored. On the agriculture side, continuous monitoring occurred for vine distribution to eligible HH, frequency of home visits by VAEOs for monitoring, and OFSP production. The findings of these M&E activities are summarized in this section. Also, a Mother–Baby trial of 16 OFSP varieties (11 clones and five released varieties) were evaluated for two growing seasons, 2016/2016 and 2016/2017. These clones and varieties showed good adaptability in all sites where experiments were set. However, 3 clones—'Naspot 12' (which grows vigorously but with minimal root formation), 06/069 (which has poor vegetative and root yield), and D6-02 (does not perform well, especially in moisture-stress soil) were deemed not to perform favorably in all the selected agroecologies. Researchers and farmers recommended these be dropped from the cohort. For that reason, it was recommended that 13 varieties (eight clones and five released varieties) be taken to the next step of the release process (i.e., distinctiveness, uniformity, and stability and national performance trials).

Second, a qualitative formative gender evaluation study was used to assess the influence of gender on project implementation [23]. Additionally, a rapid market assessment was carried out to determine the commercial potential of OFSP in the project intervention districts and beyond [6]. Both studies used qualitative methods of focus group discussions and semi-structured interviews with key informants. Section 3 summarizes the findings of these studies.

Finally, a two-round cross-sectional household survey of farmer HH with children under 5 was conducted. The survey compares outputs and outcomes between beneficiary HH at baseline and at endline of the project's implementation. The baseline HH survey was conducted by CIP and district LGA partners between September and December 2015. The endline HH survey was designed and conducted between August and October 2017 by the same team after 25 months of project implementation (June 2015–July 2017). Section 4 summarizes the findings of these surveys.

Table 1. VISTA–Tanzania Outcome Logic

Objectives	Outputs	Direct Outcomes	Development Outcomes	Impacts
Objective 1: Increased production and consumption of OFSP varieties through an integrated agriculture-nutrition technology set	5 agro-ecologically adapted OFSP varieties with market-preferred attributes available for uptake by root producers. 28 entrepreneurs establish financially sustainable medium-scale seed (and root) enterprises linked to upstream source of quality pre-basic OFSP planting material and downstream individual and community group demand for planting material. 21,000 smallholder farmers receive OFSP planting material and training.	Planting materials of nutritious and productive OFSP varieties widely available. Male and female smallholder farmers plant quality OFSP vines and apply improved agronomic practices.	Increased production and availability of nutritious OFSP in HH and local markets Increased productivity and intensification of OFSP within diversified cropping systems	Increased incomes by smallholder farmers due to increased production and adapting of new technologies Better food security among the community
Objective 2: Improved nutrition knowledge and practices	17,500 HH receiving SBCC, including knowledge on OFSP utilization and consumption. 700 community heads (staff) trained in improved nutrition counseling. 5 nutrition messages and counseling in target districts including vitamin A-rich foods and OFSP	Caregivers have improved knowledge of nutritional importance of OFSP and vitamin A. HH have improved capacity to utilize OFSP for all members with focus on infant nutrition.	Increased intake of OFSP and other vitamin A-rich foods by vulnerable HH members	Improved dietary diversity, in particular, improved levels of vitamin A intakes and among vulnerable HH
Objective 3: Root producers and traders utilize improved storage and marketing of fresh OFSP roots	Technologies for improved storage and marketing of fresh roots disseminated. Selected fresh OFSP root market chains improved.	Improved root storage practices. Increase availability of OFSP roots in selected markets. Increased gender-equitable income opportunities for OFSP farmers.	Reduction of on-farm postharvest losses OFSP fresh root markets profitably supplying nutritious foods	Increased agricultural incomes in SP value chains, with at least 50% of this income accruing to women
Objective 4: Improved evidence-based and policy support	30 staff from government of Tanzania and NGOs trained in SP ToT. Strengthen the evidence for OFSP production and nutrition support in target districts. Learning events for stakeholders at district and national levels.	Increased knowledge on SP and technical capacity in key organizations for program implementation. "Business case" for each technology developed for different farmer types and consumers. Stronger awareness of agriculture and nutrition linkages in policy forums and wider society.	Improved quality of SP and wider agriculture–nutrition programming and service delivery Improved policy and investment environment for nutrition-sensitive agriculture	Increased investments in scaling-out OFSP technologies beyond target districts

2.1 Summary of Achievements

The VISTA–Tanzania monitoring component was designed to support the broader evaluation strategy by assessing project implementation and measuring outputs. To ensure consistent implementation of the delivery strategy, regular HH- and community-level monitoring was conducted. We employed qualitative and quantitative methods to monitor, collect, and analyze key indicators associated with the agriculture, nutrition, and market components of the project. Project implementing partners, key stakeholders, and CIP staff met on a quarterly basis to review monitoring data and to discuss project progress and any constraints that might be affecting our ability to reach project goals in a timely manner.

To assess the agriculture component, we continuously tracked HH distribution of vines and frequency of home visits by VAEOs for supervision of OFSP production. For the nutrition component, we monitored pregnant and lactating women's clubs and numbers of women per club session. The monitoring forms were digitized and the system provided key information on the project reach and effective coverage.

During VISTA–Tanzania, 831 group leaders, including 157 CHWs, received training on OFSP production, agronomy, and utilization. The 674 community group leaders from this lot, who were mainly W/VAEOs, were trained during the first and second step-down ToT course, "Everything you ever wanted to know about sweetpotato." Separately, however, the CHWs were further trained on child health and nutrition, which they required to step-down to pregnant and breast-feeding women. Over the 3 years (2015–2017) of the project, 21,876 primary caregivers of children under 5 attended any of the 1,167 pregnant and lactating women's group counseling sessions (Table 2). Also, 30 SREs were established and trained on agribusiness development, while 13 research scientists from the Ministry of Agriculture's Division of Research and Development received training on management and statistical analysis of agricultural research data.

A total of 27,676 rural farming HH with children under 5 received OFSP planting materials, together with brochures containing information of OFSP production practice and product use. Also, an adaptive root storage technology experiment was implemented in all seven districts of the project's intervention sites.

Table 2. VISTA–Tanzania selected outputs by district (2015–2017)

Districts	No. of Community Heads Trained in SP Production and Nutrition Counseling	Child Caregivers Attending Nutrition Counseling Sessions	Smallholder HH Reached with OFSP Vines	No. of SREs Established
Gairo	107	3,542	3,308	5
Ulanga	109	3,618	4,765	4
Iringa Rural	132	3,967	4,172	4
Mufindi	126	2,389	4,251	4
Wanging'ombe	122	2,685	3,757	3
Mbozi	118	3,462	3,624	5
Chunya	117	2,213	3,799	5
Total	**831**	**21,876**	**27,676**	**30**

2.1.1 Number of community heads trained in improved nutrition counseling

Between 2015 and 2017, 831 community leaders were trained in child health and nutrition education. This included 157 (83 males, 74 females) CHWs from 157 villages in the seven project intervention districts. This group was also trained in nutrition and counseling as well as appropriate practices on maternal, infant, and young child feeding during the first 1,000 days of life. Among the 831 community leaders, 674 community and NGO agriculture and health/nutrition officers received training at district level specifically on OFSP production agronomy and utilization (including nutrition) through a ToTs course, "Everything you ever

wanted to know about sweetpotato." These leaders in turn conducted step-down training on the information and technologies at community level among farmers. The course content for the step-down trainings also focused mainly on OFSP production and utilization (including OFSP nutrition and vitamin A). In total, 20,527 HH representatives from the seven project intervention districts as child caregivers were trained by the end of the project.

2.1.2 Number of primary caregivers attending nutrition counseling sessions

There were 140 pregnant and breast-feeding women's groups with 2,663 active members who attended monthly clubs. These clubs were attended by 21,876 individual women between June 2016 and July 2017. The club members continued to meet monthly facilitated by the CHWs to talk about better health and nutrition with emphasis on OFSP because of its high beta-carotene content. On average, 1,561 mothers participated in these club meetings monthly. The average meeting attendance was 81% across the districts.

2.1.3 Number of households provided with planting material

During the project implementation period, 5,820,649 1-ft-long vine cuttings of OFSP were distributed to 27,676 HH with children under 5 for fresh SP root production. The vine cuttings were of the five approved OFSP varieties that were promoted by the project: 'Ejumula', 'Kabode', 'Kakamega', 'Kiegea', and 'Mataya'. The beneficiary HH were also trained on improved SP agronomy and infant feeding. The vines were initially bulked once and the resulting seed used to plant 792 ha of SP crop for storage root production.

2.2 Summary of Project Outcomes

2.2.1 Developing a sustainable seed production and delivery system

Among the seven VISTA–Tanzania intervention districts, only one had had agricultural research or extension interventions with OFSP at the start of the project in 2014/2015. In other districts, either the farmers did not know about OFSP or had only heard about it over the radio. In all, less than 1% of a random sample of farmers from the project intervention districts had planted OFSP in 2014. Thus, one can generally conclude that farmers did not know much about OFSP and its advantages over other types of SP. As with other new crop varieties, an important step in establishing OFSP production is to build a sustainable seed supply, using existing capacities and linkages and strengthening these to improve access for farmers who previously had not planted OFSP. VISTA–Tanzania applied a multitiered approach to OFSP seed system development that built on experiences and partnerships from previous CIP projects in Tanzania (Fig. 2).

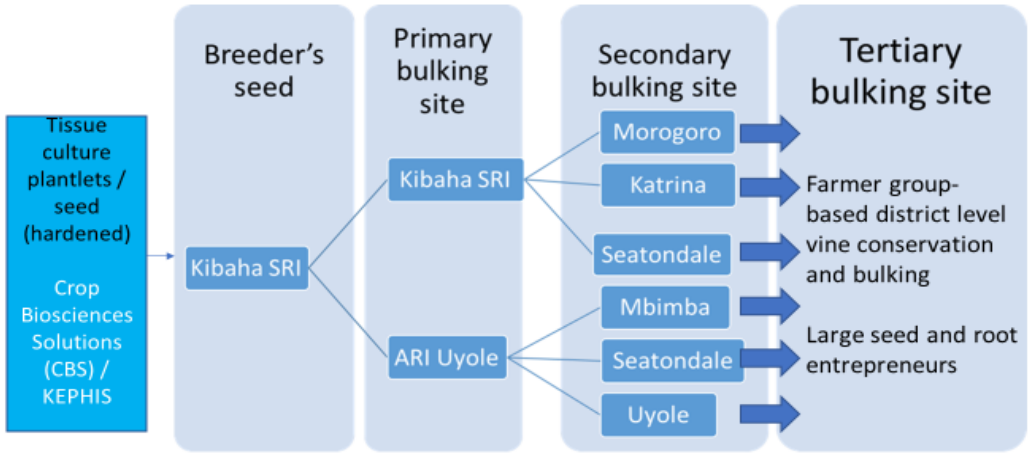

Figure 2. Seed multiplication and dissemination model for VISTA–Tanzania.

By applying this model, VISTA–Tanzania was able to establish reliable access to OFSP planting material for beneficiary farmers in the ZOI. Among the important steps and contributions were the following:

- Established community-level vine-bulking sites in each district, drastically reducing the distance and source of quality planting materials by producing it where it was most needed at village level. Before the project, some limited quantities of OFSP planting material could be sourced from central vine-bulking sites in either Morogoro or Kibaha SRI or Crop Bioscience Solutions Ltd in Arusha. However, the seed was poorly accessible, limited in quantity, and very expensive.
- The cost of vine cuttings reduced from more than TShs 100 (TShs 140 from Crop Bioscience Solutions) per cutting before VISTA to TShs. 20 during the project.
- Increased seed-bulking sites from 5 in 2014 to 60 small and medium-scale vine multipliers by 2017. Each site had at least one net tunnel for protecting the seed against insect attack. The vine conservation and bulking sites were distributed in 39 of 169 project intervention villages across the seven project intervention districts. This increased the quantity and enhanced accessibility of quality seed nearer to where it was most needed than before.
- VISTA–Tanzania initiated farmer-based seed systems with 30 medium-scale SP producers and vine multipliers. In 2017 this group produced 1,019,920 vine cuttings valued at TShs. 19,640,400 (~$8,890). Together, with all operational DVMs in 2017, the farmers produced 2,017,645 vine cuttings valued at TShs. 40,832,900 ($18,560). This was novel for the farmers who have been linked to other projects promoting OFSP in Tanzania.
- The project had a target to deliver 6.3m vine cuttings in 3 years. It was initially thought that a very small proportion would be supplied by farmers and large bulk obtained from VISTA partner institutions. Vine multipliers supplied about a third of the required vine cuttings despite having started operations in the last year of the project. However, they demonstrated a huge potential that was not being used to full advantage by previous projects. The VISTA project was responsible for providing initial clean planting material, assess its health with national partners during farmer-managed vine bulking, and take delivery when the seed was ready. (Previously, CIP had assigned production of planting material to national centralized partner institutes.) After 1 year, it was discovered that they will not be able to produce the required seed and deliver it efficiently.
- The proportion of farmers who produced OFSP from a random sample of 550 HH increased from 0.8% in 2015 to 41.6% in 2017; over the same period consumption increased from 0.4% to 46.1%. The key constraint to why OFSP was not being produced was lack of planting material. The VISTA–Tanzania production and distribution model increased availability and accessibility.

3. UNDERSTANDING GENDER AND MARKET CONTEXT

3.1 Findings of the Gender Formative Study

To understand gender roles in the production and utilization of SP in the project intervention areas, a qualitative formative gender evaluation was conducted in seven districts in the Mbeya, Iringa, and Morogoro regions. Both men and women generally agreed on the key threats to food security, such as climate variability,

lack of finance, and pests and diseases. SP was considered in most of the men and women's focus groups as a commodity that ensures food security because of its drought tolerance, early maturity, and suitability as a rotation crop in the farming system attributes. However, because its production and commercial value are limited, SP was not ranked highly in many of the women's focus group discussions. Men, too, regarded it as a support crop for domestic use and often allocated small pieces of land for its cultivation.

3.1.1 Is sweetpotato a "woman's crop"?

SP is often regarded as a "woman's crop" because of its low commercial value and the gender division of labor and responsibilities within families. However, the study showed that men help their wives produce SP. Additionally, trends regarding its cultivation seem to be changing. For example, both men and women perceived that there was more collaboration within HH in agricultural tasks related to SP than before because men and women were targeted with training and were aware of both the commercial and health benefits that could accrue from SP cultivation. Men were more likely to raise production constraints than women were. Women, on the other hand, mentioned that they often had the least productive land assigned to SP whereas men's land parcels were often fertile and assigned to crops of their preferred choice.

HH resources such as fertilizer and other quality inputs were spent on men's land parcels and, therefore, crops of men's preference but not for women. Men were not willing to invest in SP because of a perceived lack of benefits from cultivating the crop as well as their regard for it as a secondary crop or a woman's crop.

3.1.2 OFSP planting material: a business opportunity for women and men?

Men and women had different perceptions in relation to vine production and demand. For example, women were aware of marketing opportunities for vines and roots as a reason for the increased production of and demand for planting material. Men on the other hand considered SP as a minor crop and demand for its vines had either stagnated or even declined. The differences in perception may be related to the role that SP played in the lives of either sex. It was considered a top income earner for women, but men had other sources of income in crops such as maize and sesame and from off-farm employment. It was not obvious that SP planting material businesses was viable. Although men and women said that they would be willing to buy OFSP vines, most were not willing to purchase vines of white-, cream-, or yellow-fleshed sweetpotato varieties because they were freely available in the community and farmers could also save their own. They were, however, willing to purchase vines of OFSP varieties because their planting material was not yet available in adequate quantities in the community and also because they had been targeted for awareness raising on the health benefits of OFSP.

3.1.3 Access to training and extension services

Access to and participation in training by women were enhanced when the events were held in their village; training held outside the village tended to favor men. Even when women attended training, however, the quality of their participation was often regarded by men to be low, since some of them were afraid to speak in public. The facilitation methods did not address this. The study participants stated that there was need to improve women's participation through facilitation methods that engaged them, such as asking them questions directly and managing group dynamics to ensure that men did not dominate the discussions. Additionally, follow-up visits could help both men and women farmers in technology adoption and utilization.

The sources of nutrition information differed between men and women. Women groups mostly acknowledged the VISTA project and Njombe Agriculture Development Organization as their main sources of information on OFSP. Men on the contrary got information from other farmers or members of their groups who had

attended training. We also found that in many cases nutrition information was given at child welfare clinics, which men did not normally attend. From the data, however, men who had started cultivating OFSP cited its nutritional benefits as one of the reasons for doing so. It is therefore important that men and women get equal access to OFSP nutrition information, considering their status and influence in family decision-making in food production and utilization.

3.2 Results of the Rapid Market Assessment

To determine the commercial potential of OFSP, a rapid market assessment was conducted in the project intervention districts. In each district, two markets were visited and 328 individuals as SP traders and consumers were interviewed. The results indicate that SP produce markets varied in size, structure, and nature of operations. The markets were categorized as large, medium, or small. The most common source of fresh SP roots in the large markets was Songea region. About 89% of the traders obtained SP supplies directly from farmers, meaning that they could have been getting a fair price by avoiding brokers. Retailers constituted 76% of the SP business, 13% did both wholesale and retail trade, and wholesalers constituted 8%. Women formed 77% of the retail and 63% of the wholesale traders. White-fleshed sweetpotato varieties were the most traded, followed by yellow-fleshed varieties and then OFSP. About 46% of the traders, mostly women, had heard about OFSP; however, only 39% of the traders were aware of the nutritional benefits of OFSP.

The most common form of transport for SP was the bicycle in Iringa and Mbeya regions and the ox cart in Morogoro Region. The most common unit of measure in SP trade was a 20-L bin. The mean volume purchased by traders was 35.6 kg/month in the peak seasons and 25 kg/month in the lean seasons. The traders had informal agreements with their trading partners and had formed social networks, especially in Morogoro and Iringa. Among the SP traders, at least 33% had accessed to credit to enhance their sweetpotato businesses, mostly from savings and credit cooperatives.

SP consumption data indicated that 61% of the consumers were unaware of OFSP, but the general perception was that its demand was on the increase. Over 70% of the consumers bought SP at least once a week, and the purchase factors that were considered important included root size, skin color, and extent of root damage; flesh color and price were also important. Data indicate that the volumes of SP traded by individual traders were low, however; their cumulative amounts were substantial and contributed significantly to agricultural commodity trade in the regions. Female traders were crucial to SP trade despite the small volumes they handled. Their frequent SP purchases ensured consistent availability of this food resource in the market. Amongst the barriers to SP trade that new entrants were likely to face included taxes, inadequate knowledge of the trends and varieties in demand, ensuring consistent supply of SP for clients, and lack of ability to engage in off-season trade in the crop, which was bound to be more lucrative. OFSP trade is a lucrative option that the new commercial farmers who are being promoted by the project can engage in. They must, however, be supported to prepare production and marketing plans, build business partnerships and networks, and engage actively in SP platforms in their areas of operation.

4. EVIDENCE OF CHANGE: FINDINGS OF THE OUTCOME EVALUATION SURVEY

VISTA–Tanzania undertook a baseline survey in 2015 and published the findings of this survey in a project report in April 2016 [15]. The current report focuses on the results from the endline study and provides a

comparison with the baseline survey findings. The baseline and endline cross-sectional HH surveys assessed the progress, outcomes, and possible impact of the project intervention over 3 years. Specific objectives of the endline study, vis-à-vis HH with children aged 6–59 months, therefore were to:

- Assess knowledge on SP and uptake of OFSP production and farming practices
- Estimate caregiver knowledge on vitamin A and vitamin A-rich foods, including OFSP
- Determine the contribution of OFSP to improved vitamin A intake
- Estimate the consumption of OFSP and other vitamin A-rich foods by caregivers and children aged 6-59

4.1 Project Sample Description

The endline survey had aimed to interview 550 HH representatives as primary caregivers of children aged 6–59 months; however, 547 were interviewed, representing 99.5% of the targeted sample size. Among the HH representatives who were interviewed, 293 (53.6%) had participated in the 2015 baseline survey (Table 3). The participating caregivers, including 21 men, had a median age of 32 years (inter-quartile range [IQR] 26–38) and most were in monogamous relationships. Among the study participants, the median age of the HH head was 38 years (IQR 32–47); women constituted about 15% as head of HH. About 81% of the study-participating head of HH had completed at least primary school level of education compared with 79% of the young-child caregivers in this study with similar education level.

Comparison of selected data variables between the baseline in 2015 and the endline in 2017 showed that the average median age of child caregivers increased from 30 years in 2015 to 32 in 2017 (Table 3). More than half of the participants (54%) took part in both surveys. The level of educational status among child caregivers increased and the proportion of participants that had not attended any formal school decreased from 20% in 2015 to 10% in 2017. Similarly, the proportion of HH heads that had not attended school at all decreased from 10% in 2015 to 6% in 2017 (Table 3).

Table 3. Differences in socio-demographic characteristics between baseline and endline participants

		All[1] (N=1,096)	**Baseline (n=549)**	**Endline (n=547)**	**P-Value[2]**
Age of Mother/Caregiver in Years, median IQR		31 [25–38]	30 [24–27]	32 [26–38]	0.001
Average Age (Years) of Members >= 5—median IQR		21 [11–33]	20 [10–32]	21 [11–35]	0.01
Head of Household Education Status					
	No schooling	87 (8.0)	57 (10.4)	30 (5.5)	
	At least primary	863 (79.1)	422 (76.9)	441 (81.4)	0.02
	At least secondary	124 (11.4)	59 (10.8)	65 (12.0)	
	College or university	17 (1.6)	11 (2.0)	6 (1.1)	
Caregiver/Maternal Education Status					
	No schooling	667 (15.0)	446 (19.5)	221 (10.2)	
	At least primary	3,217 (72.4)	1,566 (68.6)	1,651 (76.5)	< 0.001
	At least secondary	519 (11.7)	251 (11.0)	268 (12.4)	
	College or university	38 (0.9)	20 (0.9)	18 (0.8)	

[1] The percentages represent column percentages.

[2] Pearson's chi-squared for proportions and nonparametric equality-of-medians test for averages.

4.1.1 Household wealth index

As a composite measure of HH aggregate living standard, the wealth index for the endline survey did not show substantial differences across districts (Fig. 3). A large proportion of HH were in the high and medium wealth index categories. Most HH in all the districts except Mufindi and Iringa had high wealth index compared with low and medium. Mufindi District had 42% of the HH in the poor wealth index category.

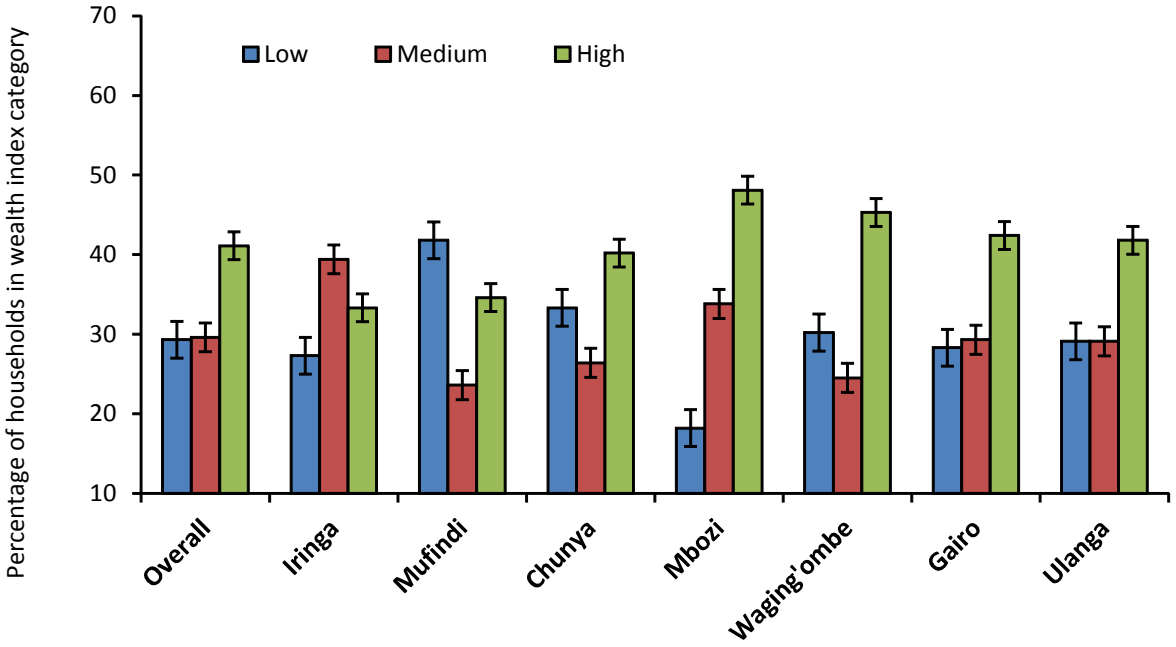

Figure 3. Aggregate wealth index among HH implementing VISTA–Tanzania at endline assessment in 2017.

4.1.2 Community access to health, agriculture, and nutrition special intervention activities

The average median distance to nearest market from the village communities that were implementing the VISTA–Tanzania project was 6 km, and most access roads in the survey districts are rugged earthen. Some 33% of HH preferred walking to the markets, followed by those who used motorcycle (*boda boda)* to access the markets for foods and other HH goods. All villages included in the endline survey reported at least one kind of agricultural intervention provided by the government, private sector, or both, particularly in provision of seed (41%), fertilizer (27%), and extension services (24%).

Eighty-eight percent of the villages indicated presence of health activity interventions mainly in nutrition and health education (18%), vitamin A supplementation (17%), immunization campaigns (17%), and provision of insecticide-treated mosquito nets (15%). Most of these interventions were carried out by Ministry of Health with other partners. At least 90% of the village heads revealed presence of villages' health committees that oversee health and nutrition issues in the community. However, the survey was not able to assess the composition, skills, and knowledge base of these committees.

4.2 Changes in Household and Young Child Dietary Diversity

This outcome falls under the development outcome of objective 2 in the project's logframe (see Table 1, p. 6). The HH and children dietary diversity scores based on a 24-hour recall of key food group consumed reflected access to quality diet. The HH score was from 13 food groups, while the young child score was from a maximum of 9 food groups. The HH dietary diversity in 2017 differed among the districts, with Chunya and

Wanging'ombe having the lowest scores of 5.7 and 5.9, respectively. Iringa had the highest HH dietary diversity score (7.4). For young-child dietary diversity score, Chunya (4.2) and Wanging'ombe (3.9) had the lowest scores out of a possible 9 food groups. Iringa reported the highest score of 5.1.

When broken down into high, medium, and low dietary diversity categories, over 90% of the HH in the project intervention districts were in the "high" dietary diversity score (Fig. 4). The same scenario was observed among the young children diet, where the dietary diversity score by category mirrored that of other HH members, although slightly more than 80% of HH young child dietary diversity score was in the high category.

As expected, the overall mean HH diet diversity score at endline was higher than at baseline. The mean HH diet diversity score at endline survey was 6.7 compared with 3.9 during the baseline, representing a 72% increase between 2015 and 2017. At the same time, young-child mean dietary diversity score increased from 3.9 in 2015 to 4.6 in 2017, representing an increase of 18% for the 9 food groups considered (Fig. 4). The consumption of OFSP among the HH and among young children showed great improvement between the baseline and endline. Data showed that 46% of the HH and 42% of the reference children had consumed OFSP in the past 24 hours before endline HH assessment. This was a large and significant increase over the baseline in 2015 when only 0.4% of both HH members and young children consumed OFSP 24 hours prior to the survey. Data further indicated that most of the families obtained the OFSP from their farms.

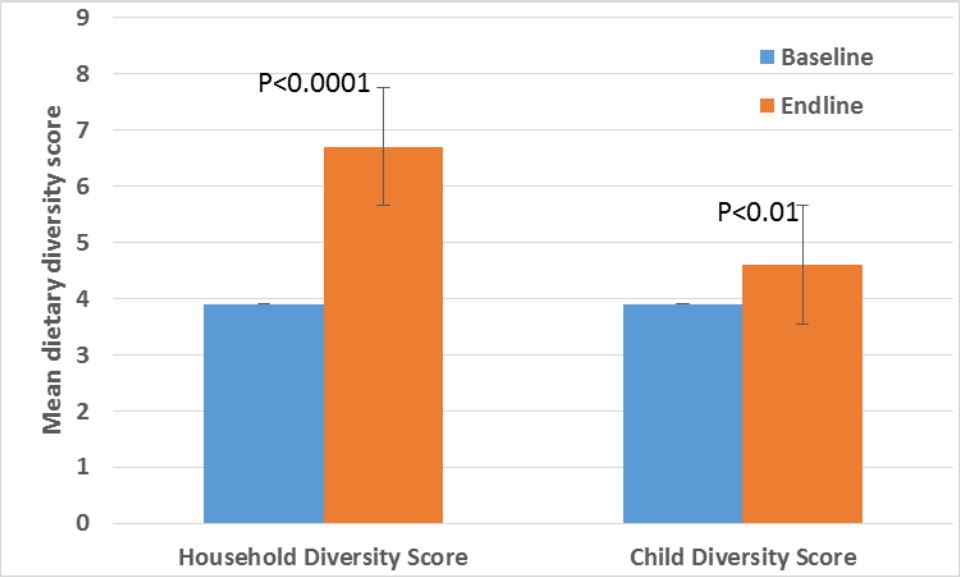

Figure 4. Differences in HH and young child dietary diversity score between baseline and endline participants.

HH consumption of vitamin A-rich foods at the recommended 6 days a week increased from 17% to more than 26%, representing an increase of 63% between baseline and endline levels. There was also an increased intake for children aged 6–59 months from 16% at baseline to 29% at endline (Fig. 5). These improvements could be attributed to the project's nutrition activities in HH in the intervention districts receiving SBCC, including knowledge of OFSP consumption and utilization.

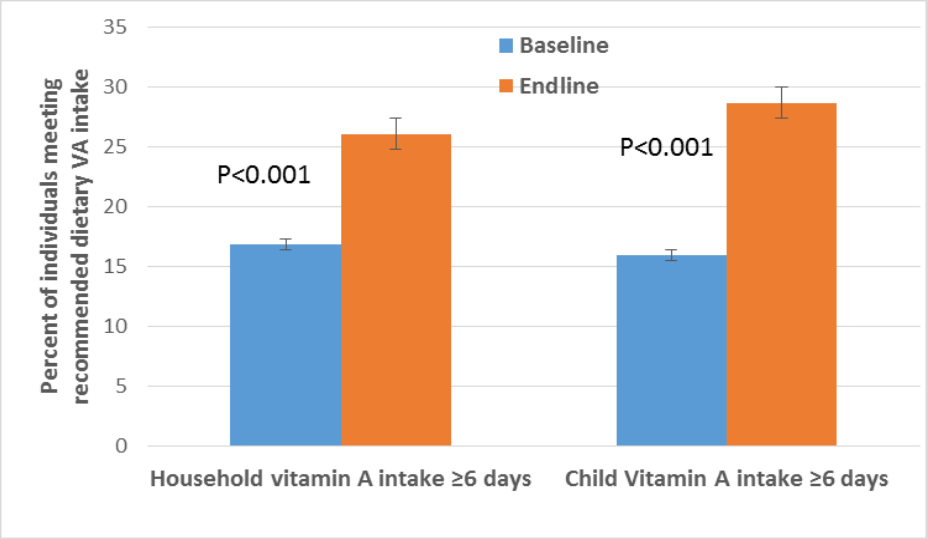

Figure 5. Differences in vitamin A intake between baseline and endline participants.

HH nutrition knowledge in general, and vitamin A in particular, shows that 30% of the respondents were categorized as having a high vitamin A knowledge score. There were no significant ($p \leq 0.05$) differences among the seven intervention districts (Fig. 5). About one-third of respondents from each of the districts had "high" knowledge of vitamin A. Health units (52%) and schools (27%) represented the most common sources of vitamin A knowledge; this was followed by CHWs (12%) as the third most frequent source of information on vitamin A. About half of the HH (50%) that participated in the endline study listened to the radio daily or at least weekly. Among them 29% heard announcements and messages concerning OFSP during the past year. About 9% of the respondents obtained information about OFSP on the TV during the past year.

Change in consumption of vitamin A-rich foods from baseline to endline

There was a modest increase in consumption of vitamin A-rich foods among both the reference child caregiver. The overall consumption of vitamin A-rich food for children at the recommended 6 days/week was 29% across the project intervention districts, compared with 26% among the caregivers. Ulanga District had the highest proportion of children consuming vitamin A-rich foods (47%), followed by Gairo (31%) and Iringa (30%). Chunya and Wanging'ombe districts had the lowest percentages of both children and caregivers consuming vitamin A-rich foods. Approximately 67% of children in the project intervention districts that are below 5 years old received vitamin A capsules in 2017. This was lower than 93% of children aged 6–59 months receiving the recommended two doses of vitamin A per year at 6-month intervals in Tanzania [21].

One of the objectives of VISTA–Tanzania was to improve caregivers' knowledge about vitamin A, the benefits of OFSP, general nutritional knowledge and specific knowledge concerning child health care practices, and health-seeking behaviors. Assessment of HH nutrition knowledge in general, and vitamin A in particular, indicated an improvement in vitamin A knowledge among caregivers from baseline to endline. About 33% of the respondents in the endline study were in the "high" score category compared with 20% of similar category at baseline (Fig. 6). The most common source of vitamin A knowledge was the health units (52%), followed by schools (27%) and CHWs (12%). There was also an improvement in sourcing OFSP messages from the mass media: 29% of project beneficiaries at endline compared with 22% during baseline received messages and information on OFSP over the radio. About 3% of beneficiaries at baseline compared with 9% at endline received messages on TV.

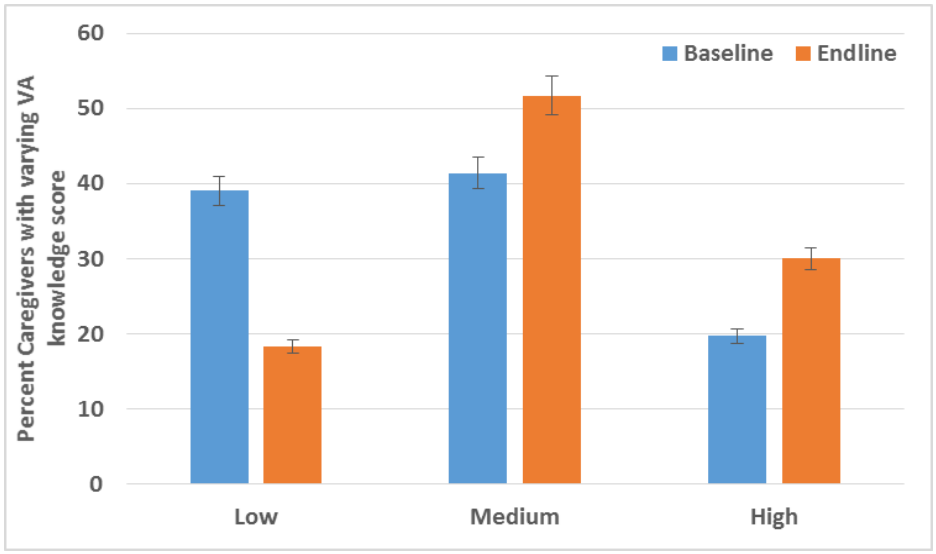

Figure 6. Differences in vitamin A knowledge score between baseline and endline participants.

The VISTA–Tanzania project intervention significantly improved caregiver health-seeking and childcare knowledge from baseline to endline. The average health- and childcare-knowledge score of caregivers at endline was 9.3 compared with 7.3 at baseline; representing an increase of 27% between 2015 and 2017. Further, there was a significant improvement in the proportion of caregivers with high health and childcare knowledge score at endline compared with baseline (Fig. 7). Here, 57% of caregivers had higher health-seeking and childcare knowledge at endline compared with 18% at baseline. This represents a twofold increase between 2015 and 2017.

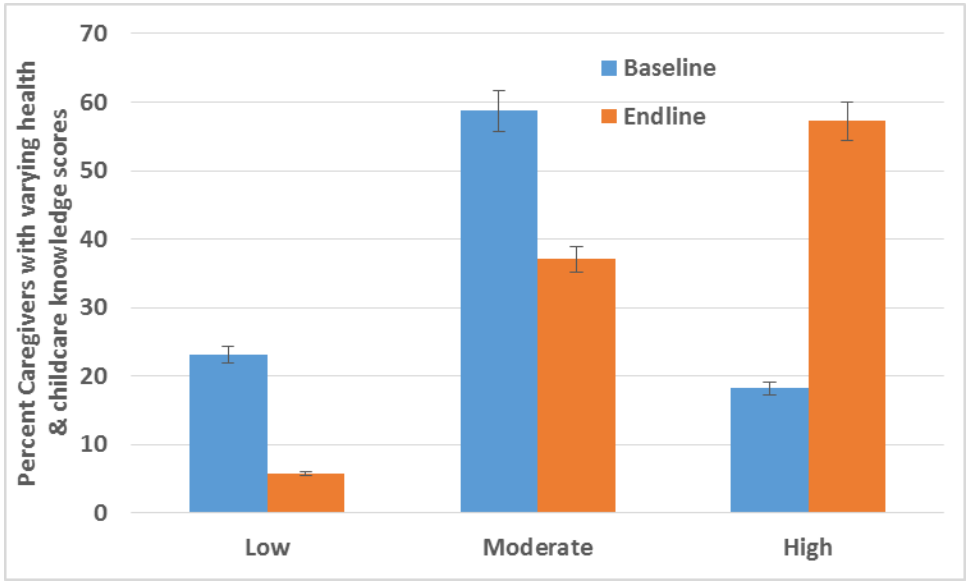

Figure 7. Differences in health- and childcare-knowledge score between baseline and endline participants.

4.3 Changes in Household Food Security

This section looks at the one of the key project impacts in the logframe: improved food security among HH and community. Food security is defined as a state in which "all people at all-time have both physical and economic access to sufficient food to meet their daily dietary needs for a productive and healthy life"[18]. In this analysis, two types indicators were created to classify HH into different food security groups; indicators based on scale score and indicators based on prevalence. The Household Food Insecurity Access Scale (HFIAS) median average score was 1 (IQR 0–4), implying that majority of the HH in the intervention areas were food secure, with the exception of Gairo District, which had a relatively higher median average score of 4 (IQR 0–7) by 2017.

The household food insecurity access prevalence (HFIAP) categorized into four levels indicated that about 10% of the HH had severe food insecurity (Fig. 8). However, there were variations among districts, with Gairo being the most food insecure, where about 25% of the HH experiencing severe food insecurity in 2017. Mufindi and Chunya had less than 2% of the HH experiencing severe food insecurity, indicating these districts were generally food secure. To get a better situation of the food security, HH were asked about which months in the past year they received fewer than two meals a day from their own resources or received relief food from an external source. Most HH experience food shortages between February and March, where they failed to get at least two meals a day or had to get food from external sources as food assistance. These months coincided with the beginning of the rainy season, planting of annual crops, or new annual crops.

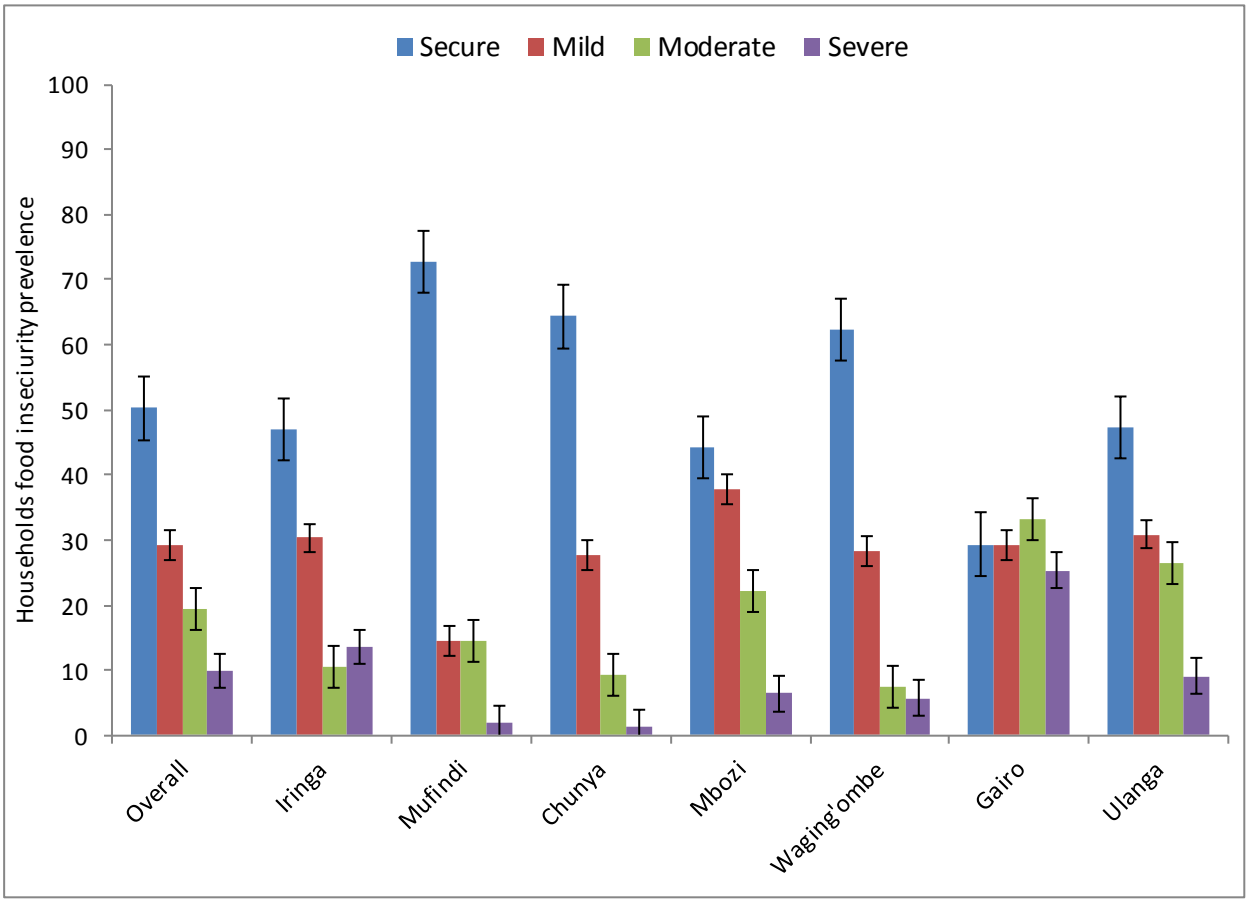

Figure 8. HFIAP in the VISTA–Tanzania project intervention districts in 2017.

There was a significant improvement in food security among the participating HH from baseline to endline. Using the mean score HFIAS, the proportion of HH with low food insecurity (score of 0–2) decreased from 32% at baseline to 53% during endline (Fig. 9).

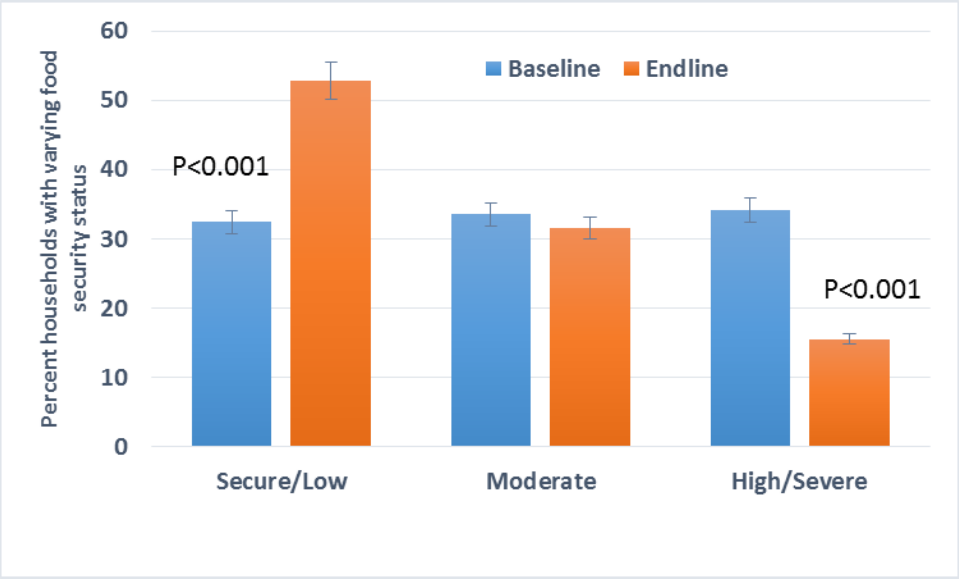

Figure 9. Differences in HFIAS score between baseline and endline participants.

The proportion of HH growing SP increased from 45% in 2015 to 79% in 2017, although sales of agricultural products decreased from 40% in 2015 to 26% in 2017 (Table 4). HH involvement in casual labor and informal businesses also showed significant reductions between 2015 and 2017.

Table 4. Differences in SP production and other project output and outcome variables from baseline and endline

		All[1]	Baseline	Endline	P-Value[2]
Households grow SP					
	No	1,089 (37.3)	781 (54.6)	308 (20.7)	< 0.001
	Yes	1,831 (62.7)	650 (45.4)	1,181 (79.3)	
Households agriculture status					
	Principal	2,428 (87.5)	1,224 (88.8)	1,204 (86.2)	0.04
	Secondary	347 (12.5)	154 (11.2)	193 (13.8)	
Sold agricultural products since beginning of year[3]					
	No	1,931 (66.9)	850 (59.7)	1,081 (73.8)	< 0.001
	Yes	957 (33.1)	573 (40.3)	384 (26.2)	
Done casual labor since beginning of year[3]					
	No	2,078 (71.7)	979 (68.6)	1,099 (74.8)	< 0.001
	Yes	820 (28.3)	449 (31.4)	371 (25.2)	
Involved in informal business since beginning of year[3]					
	No	2,408 (83.0)	1,144 (80.1)	1,264 (85.9)	< 0.001
	Yes	492 (17.0)	285 (19.9)	207 (14.1)	
Self-employment since beginning of the year[3]					
	No	2,223 (76.7)	1,216 (85.3)	1,007 (68.3)	< 0.001
	Yes	677 (23.3)	210 (14.7)	467 (31.7)	

[1] The percentages represent column percentages.

[2] Pearson's chi-squared for proportions

[3] Since 2015 for baseline; and since 2017 for endline survey.

The endline study of the project revealed a significant increased interest in SP growing. During the baseline study in 2015, about 47% of the sample target project beneficiaries cultivated SP during the 2014/2015 cropping season (Table 5). However, during the endline survey, 95% of the participants reported growing SP in the 2016/2017 cropping year. After the 3 years of VISTA project intervention, OFSP varieties became the dominant and preferred choice of many HH. Data showed that 42% of the respondents were producing OFSP compared with the 0.8% before the project intervention in 2015. In 2015 SP production was dominated by white-fleshed (73%) and yellow-fleshed varieties (26%), with OFSP only at 0.8%. After project intervention, the preferences of white- and yellow-fleshed varieties declined to 33% and 25%, respectively.

The respondents in the endline study cultivated about 4 acres of land per HH during the 2016/2017 cropping seasons; however, there were wide variations across the project intervention districts. The average land cultivated per HH was highest (> 5 acres) in Gairo and Mbozi districts (Table 5). The most commonly produced crops during the 2016/2017 cropping seasons were maize (34%), SP (32%), and beans (14%), although variations among the districts were evident (Table 5). Maize was the topmost grown crop among all the districts except in Ulanga, where rice was predominant. SP and beans occupied the second and third positions, respectively, across the districts except in Ulanga, where maize and rice were the second and third most produced crops, respectively. The most sold crop for cash income among the districts was maize. But in Mbozi, Gairo, and Ulanga, groundnuts, SP, and rice were important crops for cash income.

Table 5. Most produced and sold crops in project intervention districts of Morogoro, Iringa, and Mbeya regions of Tanzania in 2016–2017

	Iringa	**Mufindi**	**Chunya**	**Mbozi**	**Wanging'ombe**	**Gairo**	**Ulanga**
Produced	Maize (43.0)	Maize (42.0)	Maize (35.6)	Maize (26.4)	Maize (38.7)	Maize (38.3)	SP (29.4)
	SP (35.6)	SP (35.1)	SP (34.8)	SP (25.4)	SP (37.2)	SP (35.2)	Maize (25.7)
	Beans (12.1)	Beans (19.1)	Beans (11.4)	Beans (20.1)	Beans (20.4)	Beans (18.6)	Rice (23.3)
Sold	Maize (47.2)	Maize (50.0)	Maize (41.7)	G/nuts (28.2)	Maize (72.7)	SP (42.0)	Rice (44.0)
	Beans (16.7)	SP (30.0)	SP (16.7)	Maize (25.4)	Beans (21.2)	Maize (40.7)	Maize (28.0)
	SP (13.9)	Beans (16.7)	Beans (13.9)	Beans (22.5)	SP (3.0)	Beans (16.1)	SP (16.0)

The decision-making process on how much SP can be produced improved significantly from baseline to endline. There was an increase of 65% joint decision-making by both women and spouses in the HH by the endline survey on how much SP to cultivate (Table 6).

Table 6. Differences in SP production, sales, and consumption between baseline and endline participants

		All[1]	Baseline	Endline	P-value[2]
Growing SP in previous cropping season		777/1,096 (70.9)	258/549 (47.0)	519/547 (94.9)	< 0.001
Average number of SP plots, median IQR		1 [0–1]	0 [0–1]	1 [1–1]	0.02
Ask spouse or someone else for permission to use land?		174/750 (23.2)	79/250 (31.6)	95/500 (19.0)	< 0.001
Who decides how much SP to grow?					
	Husband	77 (10.0)	41 (16.0)	36 (7.0)	< 0.001
	Wife	218 (28.3)	78 (30.5)	140 (27.2)	
	Both	476 (61.7)	137 (53.5)	339 (65.8)	
Average number of SP plots, median IQR		0.5 [0.13–1]	0.6 [0.25–1]	0.4 [0.01–1]	< 0.001

[1] The percentages represent column percentages.

[2] Pearson's chi-squared for proportions and nonparametric equality-of-medians test for averages.

There was a significant increase in HH consumption of SP leaves at endline compared with the baseline (Table 7). This could be attributed to the project's nutrition and SBCC intervention at HH level that encouraged increased consumption of all the food groups, including green leafy vegetables as a source of vitamin A. Further, the beneficiaries increased the conservation of SP vines during the dry season compared with the baseline in 2015. This could be attributed to the step-down trainings that were implemented by the project in the intervention communities that targeted the conservation of vines during the dry season to ensure availability of planting materials at the onset of the rains.

Table 7. Differences in SP knowledge and practice between baseline and endline participants

	All[1]	Baseline	Endline	P-Value[2]
Plant SP several times during one season?	155/865 (17.9)	71/324 (21.9)	84/541 (15.5)	0.02
Conserve SP during the dry period?	557/847 (65.8)	164/311 (52.7)	393/536 (73.3)	< 0.001
Ever stored SP root whole and fresh after harvest?	122/836 (14.6)	59/295 (20.0)	63/541 (11.7)	0.001
Does HH consume SP leaves	716 (73.7)	280/425 (65.9)	436/547 (79.7)	< 0.001

[1] The percentages represent column percentages.

[2] Pearson's chi-squared for proportions.

4.3.1 Household sweetpotato production

Overall, 95% of the survey participants indicated having cultivated SP in the 2016/2017 cropping year. And although Wanging'ombe District had the lowest percentage of the sample HH reporting growing SP in the 2016/17 cropping season, it was above 85%. The average acreage used for SP cultivation across the seven districts was 0.4 acres. Iringa and Gairo districts had an average of 1 acre/HH dedicated to SP production.

The main SP harvesting months across the districts were April–August; however, in most districts June and July were the peak SP harvesting months. About 42% of participants produced OFSP varieties, whereas 33% and 25% produced white-fleshed and 25% yellow-fleshed varieties, respectively. About 75% of the respondents who produced SP indicated that they were mainly for home consumption.

SP farming in the project intervention districts was found to be gender sensitive and involved both spouses in decision-making for SP production. About 66% of the participants had both the husband and wife deciding on the amount of land to be used for SP cultivation in each cropping season.

4.3.2 Trends in sweetpotato production and seed systems from baseline to endline

In 2015 the main source of SP planting material among respondents in the project intervention districts was home-based, where 91% of the participants produced their own planting materials. The remaining proportion

of farmers obtained SP planting materials from neighbors and relatives, which are all categorized as home-saved seed. However, with the aim of introducing and expanding the production and utilization of nutritious OFSP, the project deliberately undertook free mass distribution of planting materials to beneficiaries. (We considered that uptake was seriously hampered by unavailability of quality planting material of OFSP varieties.) Thus, during the endline survey, as expected most participants considered the VISTA project as their main source of OFSP planting materials: 62% of the respondents sourced SP planting materials from the project, whereas the rest got seed from their own farms (20%) and nearby farmers (11%). The business in SP planting material is not yet strong, considering that 90% of the participants got vines for planting for free with only 10% buying SP planting material from other sources. Nevertheless, this is a good indicator that SP planting material business exists and is likely to grow once OFSP storage roots become a raw material for value-added products.

4.4 Farmer Technology Exposure and Uptake

Within the 3 years of project intervention, there was tremendous improvement and uptake of OFSP and related technologies. The project promoted a number of SP technologies. These included improved nutritious OFSP varieties; net tunnel technology for healthy vine maintenance; Triple S[4] (storage in sand and sprouting) for saving planting materials as fresh roots; DVM methodologies; SP value-added product preparation; nutritious SP recipes and nutrition awareness; and harvest, postharvest, and storage technologies. The above technology uptake and utilization were assessed from a sample of HH in the project intervention villages.

A high proportion (94%) of sample HH from the project intervention districts was fully aware of the VISTA project, which they locally referred to as *mradi wa viazi lishe* (loosely translated as "the project of nutritious sweetpotatoes"), clearly differentiating them from Irish and ordinary white- and yellow-fleshed ones. Most respondents were fully aware of the project's purpose and objectives. About 60% of the young-child caregivers across the seven project intervention districts felt that OFSP was more important in their family diet than 3 years before. In technology dissemination, 91% of sample HH received at least 300 vine cuttings from the project to stimulate OFSP technology uptake.

In nutrition awareness and OFSP recipe preparation, half of the sampled HH participated in clubs for pregnant and breast-feeding women facilitated by CHWs. Through these clubs, the members learned better family nutrition, with special emphasis on pregnant and lactating women, healthy infant feeding, importance of vitamin A, and growing and eating OFSP, as well as cooking demos involving OFSP.

Triple S refers to storing fresh SP storage roots in sand and sprouting to initiate development and growth of healthy shoots for timely production of quality planting material. The endline study revealed that about 21% of the participants had ever heard about or used Triple S; this was below expectation in technology uptake. The low information and use of Triple S technology may be attributed to the method used in training and technology transfer adopted by the project. Triple S training was attended mainly by the extension officers, SREs, DVMs, and a few select farmer group leaders. These farmer categories constitute a small proportion of the project beneficiaries and is less than the sampled HH. This approach was used in anticipation that (1) the extension officers would train more farmers even from HH that were not directly involved in the project, (2) information and technology would trickle-down through step-down trainings by these select individuals, and (3) there would be farmer-to-farmer information transfer about the technology. Nevertheless, information and knowledge about Triple S in some districts such as in Wanging'ombe (42%) and Mufindi (33%) were

[4] The Triple S technology has been piloted with different types of SP—white-, yellow-, and orange-fleshed varieties.

high but extremely low in Mbozi District, where only about 5% of the participants had ever heard about Triple S technology.

The endline study revealed that only 5% of participating HH store fresh SP roots for later consumption or sale. Storing fresh SP root for later use can be an effective way of avoiding the effects of drought, reducing glut of fresh roots in the market, and stabilizing the prices of fresh roots. Storage of fresh SP roots would also improve food security and mitigate falling prices due to oversupply in the market at peak harvesting. Among the project intervention districts, only Mbozi had a significant proportion (21%) of HH storing fresh SP storage roots.

5. INTEGRATED AGRICULTURE–NUTRITION PROGRAMMING: LESSONS LEARNED

VISTA–Tanzania had a positive impact on the uptake of nutritious biofortified OFSP in terms of increased production, utilization, or consumption. It significantly improved nutrition and health knowledge and strengthened both dietary quality and vitamin A intake of HH and young children among project beneficiaries. Various factors are attributed to the successful outcomes of the project. These include a carefully designed intervention that was linked to the needs and active participation of the community while being supported by health and agriculture extension services existing in the districts and communities. Furthermore, strong supervision, an effective M&E system, generally sufficient resources, flexibility, and adaptability throughout project intervention contributed to VISTA–Tanzania's success. The following section outlines some key considerations and lessons learned.

5.1 Project Design and M&E

The project was designed and evaluated through careful planning and considered an integrated approach that included agronomy, nutrition, market, M&E, and learning components. The various members of the project implementing team with different technical backgrounds (agronomy, M&E, nutrition, marketing) contributed to the development of an M&E plan that included a logical framework that served as a project implementation tool. The framework included an outcome logic model, which was instrumental for (1) clarifying important contributions of activities from each sector to the overall project impacts; (2) helping stakeholders understand how all the parts of the project fit together and which variables to measure, focusing on the key variables in the theory of change, when and how to measure, and who is responsible; and (3) identifying some more difficult qualitative changes that underpinned success, such as the role of gender and market structures in increasing adoption, which were captured in two different research studies.

One important consideration for any scaling intervention is the need for a diagnostic phase that can identify institutional and market systems, during which implementing partners and stakeholders will co-design intervention models and methodologies. This is important to support the design and stakeholder ownership of innovation. VISTA–Tanzania undertook a 6-month diagnostic phase to enable project management to identify and contract appropriate partners and stakeholders to be part of the project's implementation; streamline partners' roles and responsibilities; and conduct target project area rapid appraisals to identify locations, technologies, partners, and varieties of OFSP available in the proposed project intervention districts. This was very instrumental in guiding and adjusting project work plans and budget and to design interventions with partners based on results of diagnostic appraisals.

During project implementation the team noted some vulnerabilities in the linkages between the different components which necessitated quarterly joint project reviews with implementing partners. One important question on sustainability was how to successfully link the agronomy and nutrition/health components together in the existing LGA district- and village-level extension services. To achieve this, the project team developed strong collaboration between the district nutrition/health officers and the district agriculture extension services, with directives from the district executive directors of each of the seven project intervention districts. This ensured that the CHWs who managed the nutrition clubs were in constant contact with the VAEOs who managed the distribution of the OFSP vines to the women and their HH. Participating caregivers who attend the nutrition club meetings were therefore certain to receive the OFSP planting materials from the VAEOs for planting on their farms. Women were also assured of being visited by the VAEOs monthly to offer them agronomic advice.

To ensure continuous availability of quality OFSP planting materials, especially at the onset of the planting season, the project developed and trained a cadre of DVMs who were strategically located in the communities to serve as the source of OFSP quality planting materials. These DVMs were supported with insect-proof net tunnels that served as mini-greenhouses in conserving clean planting materials, especially during the dry season. The availability of clean OFSP vines for distribution to project beneficiaries ensured that women and their HH would cultivate OFSP for root production and subsequent consumption.

5.2 Integration with Government Systems

The success of VISTA–Tanzania can be attributed to the coordinated integration of different project implementing partners and actors at the community (VAEOs, CHWs); district (district nutrition officers, district crop officers, district agriculture extension officers, district executive directors); and research and training institutional levels. This is in addition to NGOs involved in health/nutrition and agriculture activities in the project intervention sites. This was further strengthened by the careful planning and adaptations along the project implementation cycle. These actors actively contributed to the agriculture, health/nutrition, and market components of the project. Integration across these multiple sectors did require substantial coordination, networking, organizational, and LGA support.

There were various awareness workshops with ward and community leaders as well as continued discussions with agricultural, nutrition, and health service leaders at both district and village levels. There were also various trainings and refresher trainings on agriculture, nutrition/health, marketing, gender integration, and statistical and data management for the various implementing partners and staff working with VISTA–Tanzania. This was strengthened with regular quarterly partners' meetings for the implementation team and broader network of stakeholders of the project. The personnel, transport, and per diem costs associated with these activities comprised about 30% of total costs of the project. This fact underscores the importance of allocating sufficient resources to critical organizational and management meetings that are essential for supporting such integrated approaches.

As indicated earlier, both VAEOs and CHWs were critical to the success of the project because they actively linked beneficiaries from their communities to the other components of the project. The CHWs ensured that participants of the nutrition club meetings had access to clean OFSP planting materials which were distributed by the VAEOs and as well received monthly visits by the VAEOs who provided good agricultural practices to beneficiaries to increase the yield of the planted OFSP fields.

The project always shared the budget of the activities for each district with the district LGA team as a way of creating transparency and trust. The district also received the quarterly project report that are submitted to the donor, for their information of what happened in the past quarter on the intervention front.

5.3 Integration with Market Systems

The establishment and training (and refresher trainings) of DVMs ensured that the project had access to adequate, disease-free planting materials to disseminate to beneficiary farmer HH. This was in addition to the engagement of the 30 SREs in the project implementing districts who were able to establish financially sustainable medium-scale seed (and root) enterprises which were linked to upstream source of quality pre-basic OFSP planting material and to downstream individuals and community groups demanding quality planting material.

The two qualitative evaluations of the project indicated that opportunities exist for the marketing and processing of OFSP in Tanzania, which presents a potential incentive for both women and men to engage in the commercial farming and processing of the crop. At least 70% of the consumers bought SP at least once a week. The volumes of SP traded by individual traders were low; however, their cumulative amounts were substantial and contributed significantly to agricultural trade in the project intervention regions. Female traders were crucial to SP business despite the small volumes they handled. Their frequent SP sales ensured consistent availability of fresh roots in the market and a source of demand pull for quality seed from the SREs.

The combination of planning, design, evaluation, and learning during the implementation of this multisectoral intervention was a challenge for field teams. Such considerations must be part of the discussion when planning, choosing, and implementing evaluations of multisector intervention programs [22]. In summary, the key lessons learned in planning, implementing, and evaluating a scaling multisectoral intervention are:

- To support the design and stakeholder ownership of innovative approaches, a thorough diagnosis of institutional and market systems is instrumental. Substantial time is needed for diagnostic phase and re-designing of the implementation plan and activities based on findings of the diagnostic phase.
- Thinking through the program theory and updating the impact pathway or logical framework can ensure integration of the various sectors and disciplines and provide guidance for appropriate combination of both qualitative and quantitative monitoring.
- Because of the multisectoral nature of such an intervention, multiple evaluation components may be required to respond to the different models and disciplines of evidence present in the different sectors.
- Integration with government systems, including agriculture and health sector extension systems, is critical for successful implementation, feedback, and sustainability. VISTA invested time and resources in understanding and then supporting critical components of these public sector services, in particular LGA leaders and staff.
- Equally important, projects of this nature need to capture and further develop existing incentives within market systems to support continued investments in nutrition-sensitive agriculture. VISTA focused on the multiplication and dissemination of OFSP planting material as a strategic entry point for harnessing market forces in support of nutrition goals. This approach needs to be expanded to capture markets for roots/leaves that can create additional economic incentives for OFSP adoption to reinforce the motivation based on nutrition benefits.

6. CONCLUSION

In the end, VISTA–Tanzania was effective in integrating the pro-vitamin A-enriched OFSP into the farming and food systems of the seven project intervention districts in Tanzania. There were improvements in HH knowledge, attitudes, and practices that helped to enhance food security and diet quality at HH level and particularly for young children. Significant changes in OFSP production, farming, and consumption from baseline to endline among intervention HH with children under 5 were evident. The positive agricultural and nutrition outcomes documented throughout the project intervention period came about because HH members had been empowered by adopting OFSP technologies and management practices. There is also ample evidence that the adopted project approach was potentially conducive to longer term sustainability due to the high levels of buy-in and engagement it encouraged from the onset, particularly in terms of its capacity to mobilize community members and engage with key stakeholders, especially the local government leadership at district level, which is a basic government budgeting unit in Tanzania.

REFERENCES

1. Black, R., Allen, L., Bhutta, Z., Caulfield, L., de Onis, M., Ezzati, M., Mathers, C., and Rivera, J. 2008. Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* 371(9608):2435–260.

2. World Bank. 2006. Repositioning nutrition as central to development: A strategy for large-scale action. Washington, DC: The World Bank.

3. NBS. 2011. The 2010 Tanzania Demographic and Health Survey. N.B.S.N.T.I. Macro., Editor. National Bureau of Statistics (Tanzania) and ICF Macro.: Dar es Salaam, Tanzania.

4. Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF. 2016. Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) 2015-16. Dar es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, NBS, OCGS, and ICF.

5. K. von Grebmer, J. Bernstein, N. Hossain, T. Brown, N. Prasai, Y. Yohannes, F. Patterson, A. Sonntag, S.-M. Zimmermann, O. Towey, and C. Foley. 2017. *2017 Global Hunger Index: The Inequalities of Hunger.* Washington, DC: International Food Policy Research Institute; Bonn: Welthungerhilfe; and Dublin: Concern Worldwide.

6. Mayanja, S., Grant, F.K., Kakuhenzire, R., and Okuku, H.S. 2017. Rapid market assessment: Viable sweetpotato technologies in Africa–Tanzania. Technical Report. International Potato Center, Lima, Peru. ISBN 978-92-9060-481-5. 24 p.

7. WHO. 2008. *Indicators for assessing infant and young child feeding practices*. World Health Organisation: Geneva. p. 26.

8. Sindi, K., and S. Wambugu. 2012. Going to Scale With Sweetpotato Vines Distribution in Tanzania: Marando Bora Baseline Study. International Potato Centre: Nairobi, Kenya.

9. Grant, F., et al. 2015. Prevalence of Vitamin a Deficiency among Infants Participating in the Mama SASHA Proof of Concept Project in Western Kenya, in The Micronutrient Forum Global Conference – Bridging Discovery and Delivery. *European Journal of Nutrition & Food Safety*. Addis Ababa, Ethiopia.

10. PATH. 2009. *SASHA Project: Integrating health and agriculture to maximize the nutritional impact of orange-fleshed sweet potato: A proof-of concept action research project in Western Kenya.* USAID's Infant and Young Child Nutrition Project. [cited 2016; Available from: http://www.iycn.org/resource/sasha-project-integrating-health-and-agriculture-to-maximize-the-nutritional-impact-of-orange-fleshed-sweet-potato-the-mama-sasha-action-research-project-in-western-kenya/

11. Gorstein, J., et al. 2007. Indicators and Methods for Cross-Sectional Surveys of Vitamin and Mineral Status of Populations.

12. Lemeshow, S. and D. Robinson. 1985. Surveys to measure programme coverage and impact: a review of the methodology used by the expanded programme on immunization. *World Health Stat Q* **38**(1):65–75.

13. HKI. 1993. *How to use the HKI food frequency method to assess community risk of vitamin A deficiency*. Hellen Keller International: New York. p. 72.

14. WHO. 2008. *Indicators for assessing infant and young child feeding practices*. World Health Organisation: Geneva. p. 26.

15. Okuku, H.S., R. Kakuhenzire, and F. Grant. 2016. *Baseline survey report of orange-fleshed sweet potato knowledge, farming and consumption, and dietary practices among households with children aged 6-59 months in selected districts of Morogoro, Iringa and Mbeya regions of Tanzania*. International Potato Center, Lima, Peru.

16. Coates, J., A. Swindale, and P. Bilinsky. 2007. *Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide* (v. 3). Food and Nutrition Technical Assistance Project, Academy for Educational Development: Washington, DC.

17. Howe, L.D., J.R. Hargreaves, and S.R. Huttly. 2008. Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries. *Emerg Themes Epidemiol* **5**:3.

18. Rosen D, A., J. Haselow N, and S.N. L. 1993. How to Use the HKI Food Frequency Factors as Method to Assess Community Risk of vitamin A Deficiency. New York: Helen Keller International, Vitamin A Technical Assistance Program.

19. Radimer, K.L., et al. 1992. Compliance with dietary goals in a Queensland community. *Aust J Public Health* **16**(3):277–81.

20. Radimer, K.L., C.M. Olson, and C.C. Campbell. 1990. Development of indicators to assess hunger. *J Nutr.* **120 Suppl 11**:1544–48.

21. World-Bank. 2008. *Nutrition at a Glance: Tanzania*. The World Bank: Washington, DC.

22. Cole, D.C., Carol, L., Cornelia, L., Thiele, G., Grant, F., Girard, A.W., Sindi, K., and Low, J. 2016. Planning an integrated agriculture and health program and designing its evaluation: Experience from Western Kenya. *Evaluation and Program Planning* http://dx.doi.org/10.1016/j.evalprogplan.2016.03.001

23. Mudege, N.N, and Grant, F.K. 2017. Formative gender evaluation: Technical report on the viable sweetpotato technologies in Africa Tanzania project. Lima,Peru. International Potato Center. ISBN 978-92-9060-201. 90 p.

APPENDICES

Appendix 1: Counselling Card (Kiswahili Version) Used by CHWs in the Monthly Nutrition Club Meetings

Note that this appendix is presented as a separate pdf file.

Appendix 2: Survey Methodology

This community-based cross-sectional survey was conducted in August–September 2017 in all the seven VISTA–Tanzania project intervention districts. The project districts were Gairo and Ulanga districts in Morogoro Region; Mufindi and Iringa districts in Iringa Region; and Wanging'ombe, Chunya, and Mbozi districts in Mbeya Region. The villages in the project intervention districts were enumerated in August 2017 in preparation of sampling the villages and HH to be surveyed.

Study population. The study targeted HH with children aged 6–59 months; caretakers of these children were the primary respondents. There were no known risks to these populations beyond some possible discomfort due to the need to assess certain targeted behaviors of the intervention (OFSP knowledge, production, diet practices, food consumption, etc.) or inevitable survey procedures.

Sample size estimation. The sample size of the end-of-project survey was based on the same principle as baseline survey of 2015 to enable a comprehensive and objective comparison. Similar assumptions were made on expected proportions of a HH's weekly frequency of OFSP consumption and expected changes according to data on surveys conducted in Lake Zone regions of Tanzania[8] and in western Kenya [9, 10]. The sample size calculation was made to allow for comparison of proportions between endline and baseline data, using the equation below [11].

$$n = DEFF \times \frac{\left[Z_{\alpha/2}\sqrt{2\bar{p}\bar{q}} - Z_{1-\beta}\sqrt{p_1q_1 + p_2q_2}\right]^2}{(p_1 - p_2)^2}$$

where

$\bar{p} = \frac{p_1 + p_2}{2}$ and $\bar{q} = 1 - \bar{p}$ when sample sizes are to be equal

$q_1 = 1 - p_1$

$q_2 = 1 - p_2$

$Z_{\alpha/2}$ is the Z-value for the level of significance

$Z_{1-\beta}$ is the Z-value for the Power

Based on an alpha error of 5% and power of 90%, the best estimates of sample size for the primary outcome of HH weekly frequency of OFSP consumption was 426 for the seven project intervention districts. This sample size was distributed proportionately among the seven districts using probability proportion to size sampling technique [12]. This sample size would allow comparisons for OFSP knowledge, growing practices and consumption, and dietary practices among HH between the baseline to endline. The sample size was therefore raised to 512 HH to cater for a 20% non-response.

Sampling procedure. The endline survey was conducted in the seven intervention districts of the VISTA–Tanzania project. Each district has unique characteristics, such as potential for expanding OFSP production; however, poor nutrition practices and low family income are common features among all the project target districts. The project intervention districts were purposively selected because they all fall within Feed the Future's ZOI besides having been used during the baseline survey. The survey used a multistage cluster sampling design to select the study respondents [12]. The first stage involved selecting sample points ("clusters") using "probability proportionate-to-size" cluster sampling based on the list of villages from each of the project intervention districts [12]. Thus, 50 villages were randomly selected from the total number of villages in the project intervention districts.

A list of all the HH in the selected village that met the VISTA–Tanzania project target intervention criterion was compiled with the help of VAEOs. The geographical reference of all eligible HH was recorded and included in the sample frame for random selection of the eventual respondents. Amongst these HH 11 were randomly selected for individual interviews. Thus 550 HH, each represented by a young-child prime caregiver, were identified for enumeration as a main part of the endline study. Here, a HH is defined as a person or a group of persons, related or unrelated, who live together and share a common source of food. In each of the selected HH, prime caretakers of the children were the primary respondents.

Interview modules. During the listing stage, in each village a village leader was interviewed to gather information on both the village access to services (e.g., agricultural extension services, market and health services) and on other agricultural, health, or any community development intervention that might be happening in their community. A standardized, structured, smart phone-based questionnaire was used in which the responses per respondent were directly recorded by trained enumerators.

All the survey tools were prepared by the VISTA staff in collaboration with project implementing partners, reviewed for accuracy and completeness, translated into Swahili, and pre-tested before administering in the field for data collection. Based on the pre-test results, the questionnaire was accordingly modified and finalized in consultation with the partners. The questionnaire was divided into modules, with questions in each module intended to capture different information, knowledge, attitudes, and practices among the target population about SP in general and OFSP in particular. The modules of the questionnaire were:

- **Module A** - Household Contact Information
- **Module B** - Household Characteristics: The characteristics of HH (number of members, assets); HH head (age, education, employment); mother (age, relationship to household head, marital status, education, employment, parity); and children (age, sex).
- **Module C** - Household Food Security and Dietary Diversity. HH food security assessed using the FANTA HFIAS which has been previously validated in this context [16]. Dietary diversity of the HH and caregivers utilized a questionnaire combining the Helen Keller International food frequency module informing on the frequency of vitamin A-rich food consumption [13] and the World Health Organization's 24-hours recall method that focuses on dietary diversity and acceptable diet [14].
- **Module D** - Nutrition knowledge, attitudes, and practices: Sought the mother's or caregivers' knowledge on nutrition and vitamin A, including OFSP and other vitamin A-rich foods.
- **Module E** - Agriculture: Sought information on agricultural production, use of agricultural products, and income derived from agriculture, including OFSP and knowledge and attitudes about SP agronomy.
- **Module F** – Project Exposure and Uptake; that included access to OFSP vines for planting; attending OFSP field days and demos; and if ever participated in pregnant and breastfeeding mother's club run by the village-based CHWs.

At enrollment for each respondent, data were collected on basic socio-demographic characteristics such as age, marital status, education, occupation, and HH size and composition. Data on agricultural resources and HH assets were also collected to provide a context for understanding the overall results of this research.

Field methods for data collection. There were two teams of fieldworkers during the data collection phase of the survey. Each team comprised 11 enumerators, a team leader among enumerators, and a CIP staff as supervisor. The team leader had the responsibility for visiting teams in the field, ensuring that HH are

selected accurately and adequate survey tools and other logistics are available. The supervisor was responsible for deciding how to overcome unexpected problems. Each problem encountered and decision made were recorded and included in the supervision report. At the end of each work day, the team leaders conducted a wrap-up session with the team to discuss any problems encountered during the day and reviewed all questions and tracking forms to ensure accuracy and completeness. After review of each completed Computer-Assisted Personal Interviewing (CAPI)-entered data, a backup was created before closing the day's work through Bluetooth technology. The VISTA–Tanzania project's M&E specialist was responsible for the overall coordination of the survey, with backstopping from the project's principal investigator and project manager.

The interview of each caretaker of the eligible and selected HH took approximately 50–70 minutes and questions were asked in Kiswahili. Each interview was conducted at the home of the participant after she/he was reminded of the informed consent that was procured during the HH-listing exercise. At the end of each day, the team leader, assisted by the supervisor, reviewed the completed CAPI questionnaires and discussed issues and concerns about the day's interviews. Issues were addressed using field notes; if necessary, interviewers would return to pertinent HH to correct the errors.

Data management and analysis

The CSPro-supported CAPI data entry system was used to collect and collate data. In CAPI, the enumerators used smart phones to enter responses on site during the interview. The CAPI application enabled interviews to be conducted face-to-face and determined the question order, and performed editing of responses as well as skip patterns. CAPI therefore offered a flexible approach to collecting and editing data, resulted in better data quality, and improved the efficiency of interviewing and final data processing. The endline survey was conducted under a common goal for each village and HH sampled in the districts with the intention of pooling the data for analysis. Thus, every effort was made to ensure consistency in survey execution at every HH. All the data were subsequently combined for all the sampled villages and HH through a centralized database management system.

Data entry package, cleaning methods

After data collection and collation, reports were generated using Stata version 14.1 (StataCorp, College Station, TX) for basic logic, range, and missing data checks. The data were then cleaned and locked for analysis.

Data analysis

A Bayesian approach to statistical analysis was used for this survey for both primary and secondary data analyses. Summary tables as descriptive statistics and/or frequencies were provided for all pertinent endline variables. Continuous variables were summarized with descriptive statistics (n, median, and inter-quartile range). Frequency counts and percentage of subjects within each category were provided for categorical data.

Wealth index. The wealth index is a composite measure of a HH's cumulative living standard using the socioeconomic status (SES) concept, which usually integrates physical and social resources and HH status within a social hierarchy. It is important to measure SES because it is likely to confound many relationships intended for investigation. The traditional way of measuring SES is through estimation of income, or consumption expenditure based on the assumptions that material living standards determine social well-being. Consumption expenditure data are usually preferred to income data because they are less variable.

In low-income countries in sub-Saharan Africa, measurement of consumption expenditure is difficult because it is usually based on recall data; and respondents may not remember accurately or they may be reluctant to divulge such information. Additionally, prices usually fluctuate across time and geographic areas, necessitating

complex adjustment of expenditure figures to correct for the price differences. Furthermore, collecting consumption expenditure data requires lengthy questionnaires that must be completed by skilled and trained interviewers. As such, this approach is usually very expensive. We therefore decided to use an asset-based approach to measure SES. This is an approach that is usually used by demographic and health surveys in lieu of collecting income and expenditure data. In principle, an asset-based wealth index represents long-term SES in similar to consumption expenditure. Asset ownership, on the contrary, is likely to be based partially on economic wealth and is less likely to change in response to short-term economic shocks.

Various methods have been used to generate the asset-based wealth index, including data reduction procedure. The most commonly used method for computing SES is the principal component analysis (PCA), which determines weights for components of a wealth index. It involves replacing a set of correlated variables with a set of uncorrelated "principal components" that represent unobserved characteristics of the population. The principal components are linear combinations of the original variables, where the weights are derived from the correlation matrix of the data or the covariance matrix if the data have been standardized prior to PCA. However, this method is designed to use continuous, normally distributed data. Its application to the predominantly discrete data as in a wealth index is rather inappropriate [17].

The results from PCA cannot be used to compare the wealth indices created across countries or between rural and urban areas in the same data set. Thus, a wealth index based on ordinal variables for this data was created to allow comparison across sites and over years between the baseline and endline studies. Although this method may be preferable to PCA due to assumptions related to the data, it also requires some strong postulations about its ordinal nature. For example, the ranking of the materials used in roofing the main houses may be based on a score of 1–3; it was assumed that the scores were equally spaced from each other in this variable and in their relationships with the SES.

The wealth index was thus computed based on HH assets. The roofing material was ranked in order from tiles (3), iron sheets (2), and grass (1). The scores were normalized by dividing the given value by the highest value to obtain data with a range from 0 to 1. The wall material was divided into five categories: brick/stones (5), plastered (4), wood (3), iron sheet (2), and mud (1). Floor material was put in four category scores: earth (1), cement (2), wood (3), and tiles (4). If a HH had a toilet it was a discrete value of 1 and 0 where the HH had no toilet. However, the toilet types were further categories as outdoor unwalled (1), pit latrine (2), compost or eco-toilet (3), and flush toilet (4). Water is very critical in determining SES; thus, availability of water during dry periods was put in 14 categories: full-year piped water in the compound was given a score of 7, piped water outside the compound (6), water hawker-cart or a bicycle taxi *(boda-boda*) (5), water tank and roof catchment (4), well and borehole (3), unprotected spring and protected spring (2), and pond dam/lake, stream river (1). The distance of a water source from a homestead is an important component of SES as well. The inverse of the distance of the dry-season water source to the homestead was computed with the shortest distance having a value of 1.

The types of cooking fuel used in HH was divided into eight categories that were later amalgamated into six: animal dung (1), firewood (2), charcoal (3), paraffin (4), solar power, biogas (5), and gas and electricity (6). We assigned the type of lighting as follows: wood fuel (1), tin lamp (2), lantern (3), pressure lamp (4), rechargeable lamps (5), solar power, and electricity (7). All the scores for the different fuel resource categories were normalized from 0 to 1.

Modern HH assets such as radios were not considered as means of production; however, they contribute to family expenditure and thus to SES. Other capital assets such as tractors and water pumps contribute to production and so will impact SES. Thus, each of these assets was coded as 1 if owned or 0 if the HH does

not own the asset. The assets were radio, TV, telephone/mobile, solar panels, gas cooker, bicycle, motorized water pump, motorcycle, car truck, tractor, and generator. The cattle ownership index was normalized by dividing the total number of cattle owned by a HH by the highest number of animals owned in the sample population.

The wealth index was then created by summing the values of different HH and asset variable indices. In addition, the HH size, other socio-demographic characteristics of the head of HH (e.g., sex, education level), status of agriculture as principal activity or not, sale of agricultural products, salaried employment, self-employment, or worked as casual laborer. The wealth index scores were then grouped into tertiles; with score of 0–11 categorized as "poor"; score 12–14 as "medium"; and equal or greater than 15 as "high." The maximum score for the wealth index was 29.

Vitamin A knowledge scores. Improved nutrition was one of the core objectives of VISTA–Tanzania. Consequently, knowledge issues regarding nutrition in general and vitamin A in particular sought to explore the caretaker's knowledge of OFSP and other vitamin A-rich foods. Knowledge about nutrition in general, vitamin A, and OFSP was categorized as being correct or not according to international recommendations. The different nutrition knowledge variables scored were (1) child nutrition and growth, (2) knowledge about vitamin A, (3) importance of vitamin A, and (4) awareness of three examples of foods rich in vitamin A. Elements 1–3 were scored based on yes (1)/no (0) response. The fourth element (three examples vitamin A-rich foods) was based on number of correct vitamin A-rich foods cited. The vitamin A knowledge scores were further categorized into tertiles, with score of 0–2 categorized as "low," score of 3 and 4 as "medium," and score of 5 and above as "high." The maximum score for integrating in vitamin A knowledge was 10.

Frequency of vitamin A consumption scores. The frequency of vitamin A consumption score was calculated using the Helen Keller International food frequency index model to assess the HH risk level of VAD [18]. This model counts the frequency of how certain foods are eaten over time, although it suffers from failure to capture actual amounts of each food consumed. However, this model was validated against biochemical indicators and can be used to adequately predict if VAD is a public health problem in the population. A HH was considered to be at risk of VAD if the mean frequency of consuming vitamin A from animal sources was 4 days/week or less, or the mean frequency of total consumption of animal and plant sources of vitamin A was 6 days/week or less.

The frequency of vitamin A consumption score was calculated by first summing the number of days during the previous week the child or the caregiver consumed vitamin A-rich food from animal sources. Then the number of days the child or caregiver consumed vitamin A-rich food from a plant source summed and divided by 6. The following formula was used in calculating the index:

Weighted total consumption days (C_w) = Total number of days animal sources of vitamin A consumed (T_{VA}) + Total number of days plant sources of vitamin A consumed (T_{AP}) divided by 6.

The weighted vitamin A consumption score (C) is equal to the total number of days the child or mother consumed vitamin A-rich food item from animal sources plus the adjusted consumption from the plant source. The following animal and plant sources were included in the estimation of the index.

- Animal sources: Eggs with yolk, fresh silver fish (daga) with intact liver or dried silver fish (daga) with intact liver, liver from any animal or bird (e.g., chicken) or fish, butter, cod liver oil, vitamin A-fortified margarine (BLUE BAND) or fortified oil, Cerelac (fortified packaged cereal), infant formula (e.g., NAN, etc.), blood added as an ingredient (Mutura), and vitamin A-fortified sugar.

- Plant sources: SP leaves, all kinds of dark green vegetables, carrots, ripe mango, pumpkin, ripe papaya, OFSP and yellow-fleshed SP.

The cut-off point for adequate frequency of vitamin A intake was 6 for the weighted consumption score.

Dietary diversity index for HH. Thirteen food groups were included in the dietary diversity index calculation for HH: (1) cereals, 92) roots and tubers, 93) vegetables, 94) fruits, 95) meat and poultry, 96) eggs, 97) fish and sea food, 98) pulses, legumes, and nuts, (9) milk and milk products, (10) oils or fats, (11) sugar or honey, (12) biofortified foods, and (13) miscellaneous foods (beverages and related foods). The OFSP was categorized as a biofortified food with both high energy and vitamin A content. Each food group was scored as 0 if not consumed during the past 24 hours and 1 if consumed during the same period. The dietary diversity index was obtained by summing the scores for the 13 food groups. Therefore, the possible range of the dietary diversity index was 0–13. The HH dietary diversity scores were grouped into tertiles, with score of 0–3 categorized as "low," score of 4 as "medium," and 5 and above as "high."

Dietary diversity index for children 6-59 months of age. The food groups used for computation of dietary diversity index for children aged 6–59 months were (1) grains, roots, and tubers, (2) vitamin A-rich plant foods, (3) other fruits or vegetables, (4) flesh foods (meat, fish, poultry, and sea foods), (5) eggs, (6) pulses, legumes, and nuts, (7) milk and milk products, (8) any oil or fat-fried/cooked food, and (9) any biofortified staples. Each food group was scored as 0 if not consumed during the past 24 hours and 1 if consumed in the same period. The dietary diversity index was obtained by summing up the scores for the 9 food groups. The possible range of the dietary diversity index was 0–9. The child dietary diversity scores were then grouped in tertiles, with score of 0–2 categorized as "low," score of 3 as "medium," and 4 and above as "high."

Minimum meal frequency and minimum acceptable diet for children 6–23 months of age. Children with minimum meal frequency were those breastfed or who had not received solid, semi-solid, or soft foods the minimum number of times or more. Minimum is defined as two times for breastfed infants 6–8 months old, three times for breastfed children 9–23 months old, and four times for non-breastfed children 6–23 months old during the 24 hours. Children with minimum acceptable diet were those who had at least the minimum dietary diversity and the minimum meal frequency during the previous day.

Food insecurity and coping strategy score. HH food security was assessed using the HFIAS that has been previously validated in a similar context [16]. The HFIAS indicators provide information about food insecurity on HH level, with a specific focus on a HH's food access-related characteristics. To obtain these scores, questions were designed to take the participant through a spectrum of experiences of food insecurity. The food insecurity scenarios ranged from least severe, where the respondent would have anxiety regarding obtaining the food for the day but would still get the food anyway, to most severe (the respondent would go an entire day without eating due to lack of resources to buy food). The questions included behavior and perceptions related to HH food insecurity; anxiety and uncertainty; insufficient intakes of high quality or preferred foods; or insufficient quantity of intake of any foods (i.e., skipping/reducing meals or failing to get complete satiety) within the last 30 days before the survey [16, 19, 20]. To classify HH into different food security groups, the variables were analyzed and two indicators of HFIAS created, scale score and prevalence.

The HFIAS is a continuous measure of the intensity of food insecurity in the past 4 weeks or 30 days. The HFIAS score variable is generated by summing up all the frequency of occurrence for all the occurrence questions for each HH. The maximum HFIAS score is 27 (if HH responds "yes" for all the nine occurrence questions and the severity was reported as often (3), the minimum is zero if the HHs did not experience any

occurrence of food insecurity access problem. The higher the HFIAS score, the more food insecurity (access) the HH experienced; the lower the score, the less food insecure a HH is.

HFIAP was also reported and categorized into four groups depicting levels of food insecurity: (1) food secure HH who experience none of the food insecurity conditions or just rarely experience worry about inadequacy; (2) mildly food insecure HH who worried about not having enough food sometimes or often, and/or unable to eat preferred food, and/or eat more important diet than desired or some foods considered undesirable but rarely; (3) moderately food insecure HH who sacrifice quality more frequently, by eating more monotonous diet or undesirable foods sometimes or often, and/or had started to cut back on the quantity by reducing the size of meals or number of meals, rarely or sometimes; and (4) severely food insecure HH who experience cutting back on meal size or number of meals eaten often, and/or experience any of the three most severe conditions of food insecurity (running out of food, going to sleep hungry, or going for a whole day and night without eating). The prevalence of each category of HFIAP in simple terms is the sum of HH falling under the particular category divided by the total number of HH interviewed.

Appendix 3: Questionnaire for the Endline Survey Data Collection

Note that this appendix is presented as a separate Excel file.

U.S. Agency for International Development

1300 Pennsylvania Avenue, NW

Washington, DC 20523

Tel: (202) 712-0000

Fax: (202) 216-3524

WWW.FEEDTHEFUTURE.GOV