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Final report

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Improving Income and Nutrition in Eastern and Southern Africa by Enhancing Vegetable-based Farming and Food Systems in Peri-urban Corridors (VINESA)

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Contents

1 Acknowledgments

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Firstly, VINESA partners from the four project countries (Ethiopia, Malawi, Mozambique and Tanzania) played a central role in implementing the project in accordance to the annual workplans developed at the end of each project year. Together with the local teams in their respective countries, these partners included the following: Ethiopia – Dr. Mohammed Yesuf from Ethiopian Institute of Agricultural Research (EIAR) and Mr. Olani Wirtu from International Development Enterprises; Malawi – Ms. Grace Kamba from Africare and Mr. Thomson Chilanga from Bvumbwe Agricultural Research Center; Mozambique – Mr. Hipolito Malia from Instituto de Investigacao Agraria de Mocambique (IIAM), and Dr. Maria Isabela from International Potato Center (CIP); and Tanzania – Ms. Agatha Aloyce and Mr. Silivester Samali from Horticultural Research and Training Institute (HORTI)-Tengeru.

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Also, we greatly appreciate the expertise from VINESA's collaborating organization from Australia, the Applied Horticultural Research (AHR) through its Vegetable Agronomist Mr. Mike Titley. Mike's principle of "keeping it neat and simple" at VINESA's Best Practice Hub (BPHs) helped project teams, farmers and stakeholders to discover that simple best practices such as weeding, mulching, planting seedlings on ridges, applying compost and planting barrier crops can make all the difference between a good crop that leads to more profit, or a poor crop and miserable returns.

Finally, we wish to acknowledge the facilitation from VINESA's commissioned organization, the World Vegetable Center. Dr. Thomas Dubois, the Project Director and other Center scientists gave professional support that kept this project on track. Through linkages already in place, VINESA project has increased its partners' research-to-delivery capacity which will help to improve crop production skills, increase dietary diversity and improve market returns for vegetable growers in peri-urban settings in years to come.

2 Executive summary

Sub-Saharan Africa has a huge potential for producing vegetables to meet the income and nutritional needs of its rapidly growing population, but a lack of skills, capital and a "market mindset" hold smallholder farmers back. To overcome these predicaments, the VINESA project called ***Improving income and nutrition in eastern and southern Africa by enhancing vegetable-based farming and food systems in peri-urban corridors*** funded by the Australian Centre for International Agricultural Research (ACIAR) and Australian International Food Security Research Centre (AIFSRC) was launched in 2013. To date, VINESA has trained about 500 young farmers directly and another 6,500 farmers indirectly (through field days, demonstrations and farmer-to-farmer diffusion) in Eastern and Southern Africa on how to produce safe, quality vegetables and get better access to markets.

VINESA project's goal was to contribute to reduced malnutrition, through diet diversification, by promoting the production and consumption of vegetables as affordable sources of essential vitamins and micronutrients while enhancing youth employment and income by building their capacity for peri-urban, market-oriented, vegetable production. The purpose of the project was to improve vegetable variety and seed supply systems, enhance crop management practices and develop value chain effectiveness, and thereby increase market returns for vegetable growers in peri-urban settings in Ethiopia, Malawi, Mozambique and Tanzania. The project's objectives were: i) to identify, test and promote crop management and crop protection technologies and practices for increased and safer production of vegetables; ii) to identify, evaluate and deploy improved varieties and high quality seed of selected vegetable crops; iii) to strengthen postharvest systems by promoting technologies and practices for improved postharvest storage and more effective value chain relationships; and iv) to strengthen national vegetable research and development capacity and linkages.

Focusing on vegetable production in peri-urban corridors in VINESA focus countries, the BPH approach has been the project's most unique innovation. To bridge research and practice, and by focusing interventions on highly visible sites, the BPHs were concurrently used to (i) test and fast-track options for increased production and postharvest handling; and (ii) build the capacity of youth to explore and enable opportunities for profitable self-employment. During the last four years, the VINESA project has established and strengthened four BPHs (one in each country) as centres for crop trials, experimentation and training. The project has equipped a total of 481 (260 M/221 F) young trainees with skills to produce nutritious and safer vegetables in a profitable way. In a series of six-month training sessions, these youths have learned how to target specific niche markets, selecting other value chain players to partner with, and pinpointing and tackling postharvest losses. This practical approach increased the relevance of peri-urban vegetable production in an increasingly urbanized Africa, making vegetables an essential commodity in combatting rapid urbanization and youth unemployment.

As VINESA comes to a close in December 2017, an endline survey of outputs, outcomes and impacts was carried out using propensity score matching (PSM), in Ethiopia, Malawi and Tanzania. This study revealed that farmers who received training at the BPHs had significantly higher dietary diversity scores than their non-trained counterparts. This study also found out that training farmers on integrated pest management (IPM) improved handling of pesticides by 9% in Ethiopia, 56% in Malawi and 30% in Tanzania. Among the indirect beneficiaries in Ethiopia, this training reduced farmers' usage of pesticides by 63. Also 68% of young farmers who attended training (direct beneficiaries) at VINESA's BPHs applied various skills they acquired compared to only 4% of those who did not attend trainings (control group) leading to an increase in fertilizer use by 28% (75Kg/ha more) for trained farmers in Ethiopia and 39% (94kg/ha more) in Malawi. Application of these good practices coupled with new and better linkages to high value markets will be translated

into higher incomes, better nutrition and more resilient livelihoods for these farmers and their families in years to come.

3 Background

The issue

Dietary diversification, malnutrition and poverty are widespread problems in Eastern and Southern Africa (ESA), including VINESA target countries (Ethiopia, Malawi, Mozambique and Tanzania). Childhood malnutrition in sub-Saharan Africa is widespread, and forecast to increase by 13% to 42 million in 2020 (IFPRI, 2004). Much of the micronutrient malnutrition can be attributed to a lack of diversity in local diets. For good health, at least 400 g/day of fruit and vegetables should be consumed (WHO, 2003) but only 56% of the recommended amount is consumed in the region (FAO, 2008). This shortfall can be partially attributed to inadequate supply systems (poor adoption of new technologies and practices, leading to minimal improvements in production and supply chain practices), insufficient public education and inadequate policies (consumers are still largely unaware of the benefits of vegetable consumption, reflecting a need for improved education campaigns and policy). The lack of efficient channels for the adaptation and dissemination of research-based technologies and knowledge currently limits improvement in the target countries. For vegetables, their knowledge-intensive nature implies that a disconnect between research and practice can have dramatic consequences along the value chain. Simultaneously, demographics in the target countries are rapidly changing, with an expanding, younger population that increasingly migrates to cities but often fail to secure stable employment.

The project

Bridging research and practice can be achieved by focusing interventions on highly visible sites, thus creating BPHs embedded within both current and potential (youth) vegetable farmer clusters. Such BPHs were used in VINESA project countries to concurrently (i) test and fast-track options for increased production and postharvest handling; and (ii) build the capacity of youth to explore and enable opportunities for profitable self-employment. The BPHs have become centres for crop trials and experimentation that also serve for educational interventions, and hence empower vegetable producers with productivity-enhancing technologies within effective value chains. Based on recommendations by Waltering et al., (2011), this approach was tested in West Africa under the African Market Garden (AMG) initiative whereby farmers convened in community-based research hubs that provided the opportunity to didactically evaluate and demonstrate best practices while attracting traders and the wider public.

VINESA project was developed following the AMG initiative which has also been used in other ACIAR projects (e.g. HORT 2012/2020: Integrated crop management (ICM) to enhance vegetable profitability and food security in the Southern Philippines and Australia) in pursuing the goal to contribute to reduced malnutrition, through diet diversification, by promoting the production and consumption of vegetables as affordable sources of essential vitamins and micronutrients while enhancing youth employment and income by building their capacity for peri-urban, market-oriented, vegetable (indigenous and introduced) production (Tankouano, 2013).

Project partners

The VINESA project was carried out by World Vegetable Center together with government and non-government organisations responsible for vegetable research and development in each target country. For Ethiopia, the Ethiopian Institute of Agricultural Research (EIAR) paired with International Development Enterprise (iDE); for Malawi, Africare paired with the Department of Agricultural Research Services (DARS)/Bvumbwe Agricultural Research Station; for Mozambique, Instituto de Investigação Agrária de Moçambique (IIAM) paired with the International Potato Center (CIP). For Tanzania, the Horticultural Research and Training Institute (HORTI) paired with World Vegetable Center (WorldVeg). The project also drew from the experience of the Australian Applied Horticultural

Research (AHR), Australia on integrated crop management. These organisations were chosen as they were the most appropriate partners for a successful project. In addition the project incorporated value chain, human nutrition and gender analysis expertize through consultancy arrangements.

Project justification

The project was designed to provide positive impacts at the levels of households, communities and institutions. For individual famers and their communities, the testing of promising approaches generated knowledge, technologies and practices to increase vegetable productivity, reduce postharvest losses and connect growers to markets. By June 2017, VINESA project trained 481 (260 M/221 F) vegetable business professionals as direct beneficiaries. Subsequent efforts to extend successful technologies and management models further benefited 6,500 vegetable farming families through field days and demonstrations to help them improve their livelihood security, food and nutrition security and incomes. Although there was no funds allocated to support staff training in the project, VINESA project trained four undergraduate and two MSc graduate students while one MSc and one PhD students are currently doing research as part of their study on VINESA-related topics. These trainings enhance the human capacity of the national partners, which was further strengthened by three project taskforces ((i) production; (ii)postharvest; and (iii) nutrition, policy and capacity building), an approach that has promoted regional networking, coordination and information exchange.

4 Objectives

Eastern and Southern Africa (ESA), including the target countries Ethiopia, Malawi, Mozambique and Tanzania, is endowed with land and water resources required for the production of vegetables to contribute to food security and diet diversity. But despite the suitability of the biophysical environment, malnutrition from inadequate intake of protein and deficiencies in essential nutrients is common, both in urban and rural households. Further background can be found at the Australian International Food Security Research Centre (AIFSC) website (http://aciar.gov.au/aifsc/).

Much of the malnutrition can be attributed to a lack of diversity in local diets including limited vegetable intake which can be partially due to inadequate supply and insufficient public education as consumers are still largely unaware of the benefits of vegetable consumption. Increasing the amount and variety of nutrient-dense vegetables in diets can sustainably alleviate micronutrient deficiencies, particularly since many traditional African vegetables have high nutrient content and most importantly are culturally accepted.

Lack of efficient channels for the adaptation and dissemination of research-based technologies and knowledge currently limits improvement in the target countries. For vegetables, which require advanced skills for their profitable production, a disconnect between research and practice can have dramatic consequences along the value chain. Simultaneously, demographics in the target countries are rapidly changing, with an expanding, younger population that increasingly migrates to cities but often fail to secure stable employment. These youth can be organized into groups to collectively produce safe and high quality vegetables to sell a the lucrative markets around the cities where they live.

The project objectives were to:

1. identify, test and promote crop management and crop protection technologies and practices for increased and safer production of vegetables;
2. identify, evaluate and deploy improved varieties and high quality seed of selected vegetable crops;
3. strengthen postharvest systems the potential and feasibility for value adding and processing will be assessed, especially looking at technologies for improved postharvest storage and more effective value chain relationships;
4. strengthen national vegetable research and development capacity and linkages.

The associated research questions were the following.

1. To what extent are current vegetable production practices inappropriate and how can they be improved for increased produce quantity and quality, including safety, in the target countries?
2. To what extent can research improve the availability of improved varieties and seed to vegetable farming communities and how would this increase the supply of vegetables?
3. To what extent can research interventions to promote options for collaborative relationships, postharvest storage, value addition and processing lead to increased value chain efficiency and effectiveness and increased returns to farmers?
4. To what extent can community-immersed best-practice testing hubs help to strengthen the capacity of the national research partners for delivering improved technologies and practices?

During the last four years, many project activities to address the above objectives and research questions have been carried out in each of the four counties (Ethiopia, Malawi Mozambique, Tanzania) as indicated in Section 6 with a view to achieve planned project

outputs and milestones in Section 9. The methodology for carrying out these activities is outlined in Section 5 while a brief discussion of few study results are given in Section 7.

5 Methodology

Project approach

To bridge research and practice, VINESA project set up research, demonstration and training facilities on four sites, one in each country, which at the same time served as intervention centres to empower vegetable growers with productivity-enhancing technologies while exploring opportunities to develop effective downstream relationships. In so doing, VINESA focused its research, training and capacity building activities on highly visible sites, called BPHs (Figure 1). These BPHs have served for four years as avenues for a participatory approach to test and fast-track delivery of research-based options for increased production and postharvest strategies, and simultaneously provide young people with the skills required to for profitable self-employment.

In 2014, VINESA developed experimental protocols to set up crop trials in each the BPHs for vegetable research using standard procedures (Dinssa, et al., 2016). These protocols have been used by VINESA's research and development partners in Ethiopia, Malawi, Mozambique and Tanzania to establish crops plots for training farmers and to conduct participatory evaluation of best practices and technologies. This BPH approach also served as communication tool to other farmers and local communities to see and learn, as crops and technologies were set up with a special focus to the local agronomic, economic and socio-cultural needs.

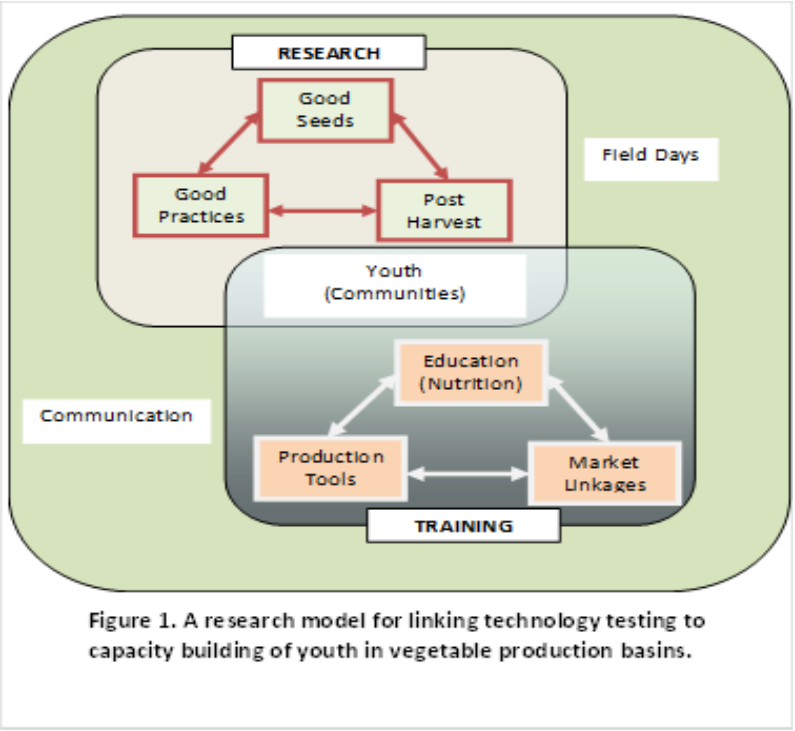

Figure 1. A research model for linking technology testing to capacity building of youth in vegetable production basins.

The training for six successive lots of 20 youths per lot at the BPHs in each country lasted for six months (one cropping cycle). Selection criteria differed from country to country but generally depended on age (18-35 years), interest in vegetable farming, a mixture of males and females, ability to read and write, access to suitable land, and willingness to share acquired skills with community members.

Project team

World Vegetable Center (WorldVeg) - Tanzania: Founded in 1971, WorldVeg is an international non-profit research and development institute whose vision is healthier lives and more resilient livelihoods through greater diversity in what we grow and eat. For over 40 years, WorldVeg has assembled a diverse pool of germplasm accessions, developed improved varieties, produced best practice production guides and postharvest techniques, and developed a selection of new products/food preparation techniques from culturally accepted vegetable crops in Africa. WorldVeg coordinated VINESA project activities in all the four countries and was responsible for the management of the project through

planning, implementation and technical expertise, monitoring of progress and evaluation of project's outputs, outcomes and impacts, financial accountability and technical reporting.

Applied Horticultural Research (AHR) – Australia: AHR is a research company with skills in vegetable agronomy and postharvest research in Australia and internationally. AHR overseen several ACIAR projects in Vietnam and the Philippines, and has managed many projects in Asia and Pacific regions over the past 15 years. AHR staff offered to the project teams in the four countries latest research-based information and practical field support to address challenges from crop production and pests and disease control.

Ethiopian Institute of Agricultural Research (EIAR) - Ethiopia: EIAR coordinates 13 federal and 52 regional agricultural research centers across different agro-ecologies of Ethiopia. EIAR develops best practices for vegetables with emphasis on indigenous and exotic vegetables, which the project will popularize through demonstration and training sessions. In Ethiopia, EIAR which is a Government of Ethiopia institute, was the lead partner for VINESA project and offered oversight on design of crop trials at the BPH, testing of pests and disease management practices, analysis of soil's chemical, biological and physical properties, and conducted multi-locational varietal performance testing.

International Development Enterprises (iDE) - Ethiopia: iDE is an international non-governmental organization that creates an enabling environment for poor rural households to participate effectively as micro-entrepreneurs in higher value agriculture market systems and to progress from subsistence to commercial farming. Over the last 35 years, iDE has developed low cost household irrigation technologies (HITs) that are designed to enable smallholder farmers produce vegetables, fruits and other high value crops across the world. In Ethiopia, iDE, supported EIAR to set up irrigation facilities, establish postharvest structures, organize farmer's field days and training, and set up vegetable collection shed at the BPH.

Africare - Malawi is a branch of Africare, a NGO with headquarters in Washington DC, USA and offices in 23 countries in sub-Saharan Africa. Africare has implemented over 2,500 projects in 36 countries in Africa, working with communities to promote food security and agricultural productivity, based on result-oriented approaches and participatory training techniques to ensure sustainability of its interventions. In Malawi, Africare was responsible for setting up and operating the country's BPH, conduct farmer's training, and identify and test appropriate postharvest technologies to reduce losses and add value.

DARS/Bvumbwe Agricultural Research Station - Malawi: Bvumbwe is an agricultural research station under the Department of Agricultural Research Services (DARS). The station works with extension staff, farmers and other development partners, including NGOs through various established mechanisms for developing and disseminating technological information. The station was in charge of design of crop trails at Ntcheu's BPH, testing and dissemination of IPM practices, conducting multi-locational adaptation trails for elite germplasm from World Vegetable Center's genebank, and development, validation and dissemination of crop national packages.

IIAM - Mozambique is the agricultural research branch of the Ministry of Agriculture, responsible for conducting and coordinating agricultural research to increase agricultural productivity in the country. IIAM works to generate knowledge and technological solutions for sustainable development of agri-business, food security and nutrition. IIAM was VINESA's lead partner responsible for setting and operating the BPH at Moamba District for farmers' training and education, value chain development activities, and setting up crop experiments at Umbeluzi Research Station to evaluate genetic materials.

CIP – Mozambique. International Center for Potato Improvement (CIP) is part of the 15-center research alliance known as the Consultative Group on International Agricultural Research (CGIAR). CIP has a long and well established presence in Mozambique with good relationships across the country and has a special focus on sweet potato research. On a one year consultancy basis, CIP supported IIAM in the analysis of nutritional

contents of vegetables, promotion of postharvest technologies to reduce losses and increase value, and conduct analysis of consumer preferences and alternative routes to markets.

Horticulture Research and Training Institute (HORTI)-Tanzania: Established in 1980, HORTI is the Government of Tanzania's research institute with a national mandate on horticultural research encompassing vegetables, fruits and flowers. In Tanzania, HORTI was the lead VINESA partner responsible for setting up the BPH at Madiira Farm, Arumeru District to facilitate farmers' education and assess to research innovations, design and evaluate soil management packages, develop IPM packages for major insect pests, and document microbial and pesticide contamination in vegetables sold in urban markets.

Project sites

Compared to traditional field crop farming, vegetable production is knowledge intensive and the harvested produce does not store well under ambient conditions and cannot be carried over long distances without major losses. Having the right production and postharvest skills and being connected to markets is a major determinant for success of any vegetable farming business. Land scarcity in the production basins around cities dictates a small intensive plot approach that is both sympathetic to human and environmental safety and allows cooperative value chain linkages to develop. These are key pillars followed by VINESA project partners in each country in choosing the sites of their BPH.

a) In Ethiopia, the original target zone was Tullu Bullu district in the central Rift Valley, an area with an enormous potential for production and marketing of a many horticultural crops. Tullu Bullu is located 100 km south of Addis Ababa on the main highway to Nairobi in neighbouring Kenya. However, the BPH was shifted from the Tullu Bolo District to the Wolisso District, some 20 km further down the original site. At the original site, it was envisaged that due to the local land tenure system, the hub will be shifting from one site to the next after each cropping cycle. The management of scattered hubs sites and follow up of successive rosters of trainees posed a severe challenge to project partners and management. After negotiation with the local administrative authorities and Peasants' Association leaders, the new site at Dembelli Ketta Framers' Training Center (FTC) measuring about one hectare was handed over to project partners in Ethiopia for VINESA project activities. This land is strategically located near the main road, among smallholder communities and along a permanent stream of water.

b) In Malawi, the project site was in Ntcheu district which is located approximately mid-way between Lilongwe (180 km) and Blantyre. Road access is excellent and it takes 2-3 hours to reach the urban markets in either of the two cities. Ntcheu district has a government-supported water scheme that allows for year-round crop production. Most of the women in the scheme, constituting the majority of the labour force, have user-right to land. These women, having started producing and selling high value vegetables to schools, hotels and hospitals in the locality, have also incorporated many young men and women in their vegetable businesses. Upon graduation, the youth have become agents for cascading new skills in their communities.

c) In Mozambique, the project operated in Moamba district, about 80 km from Maputo on the highway to Johannesburg in South Africa. Set up in a major peri-urban vegetable production zone, the project site is supported by two public irrigation schemes that cover about 500 hectares and are operated by farmers' associations. The lead partner of VINESA in Mozambique was IIAM supported by CIP, both located in the capital city of Maputo. Here, the BPH facilitated training

and mentoring of six lots youth on various aspects of vegetable value chains including production of healthy seedlings, crop nutrition and efficient utilization of irrigation water. Public agricultural extension agents are helping the returning graduates to cascade their acquired skills to their communities.

d) In Tanzania, the project sites was located in Arumeru district in Arusha region. The selection of this site was justified by rapid increase in vegetable production activities in the vicinity of Arusha City, particularly during the high tourist season (August – January). However, due to extensive use of pesticides, fertilizers and untreated waste water, quality and safety of these vegetables is questionable. Also due to small plots of land under cultivation, such vegetable produce often fail to meet market demand and preferences. To address these challenges, HORTI supported by World Vegetable Center equipped 120 youths with skills on how to make good compost, produce healthy seedlings, control pest and diseases, and cook nutritious vegetables. VINESA project also collaborate with Sokoine University of Agriculture (SUA) for training of students as well for the analysis of microbial contamination of vegetables from urban markets and their risks to consumers.

Priority crops

During the last four years, VINESA project has introduced over 64 elite germplasm with great potential to improve nutrition and market returns for farmers and their households. Selected vegetable germplasm from the World Vegetable Center have undergone multi-location testing by national vegetable improvement programs in respective countries. This germplasm included: tomato (all countries), onion (Ethiopia, Malawi, Mozambique), African eggplant (Malawi, Mozambique, Tanzania), amaranth (Malawi and Tanzania), Ethiopian mustard (Ethiopia, Malawi), sweet pepper (Mozambique, Tanzania), African nightshade (Tanzania), bittergourd (Mozambique), French bean (Tanzania), garlic (Ethiopia), broccoli (Ethiopia), hot pepper (Ethiopia), okra (Ethiopia, Malawi), beet root (Mozambique) and bitter guard (Mozambique).

Project governance

Expertise from the National Agricultural Research System (NARS) partners, World Vegetable Center (WorldVeg), project consultants (value chains, human nutrition and gender) and Applied Horticultural Research (AHR) convened into three strategic taskforces to specifically address country cross-cutting and learning issues pertaining to (i) production, (ii) postharvest and nutrition, and (iii) policy and capacity building. These taskforces ensured that the project maintained a regional focus while at the same time drawing from regional options to address more country-specific needs. The taskforces also promoted learning between the four VINESA countries.

e) The production taskforce coordinated variety testing trials and associated crop management in all countries with seed supplied from the WorldVeg's genebank in Arusha, Tanzania. The taskforce was responsible for the development and implementation of robust experimental protocols to: (i) validate and promote crop management and crop protection technologies and practices for increased and safer production of vegetables, and (ii) evaluate and deploy improved varieties and high quality seed of selected vegetable crops.

f) The postharvest and nutrition taskforce was responsible for assessing the potential and feasibility for value adding and processing options, especially looking at technologies for improved postharvest handling and value chain management. The taskforce documented information on existing postharvest technologies and local indigenous knowledge and experiences. The taskforces also promoted nutrient analysis, food preparation and cooking techniques to enhance the nutritional value of vegetable-based recipes in Ethiopia, Malawi, Mozambique and Tanzania.

g) The policy and capacity building taskforce analysed production trends, emerging markets and trade networks in view of (i) recommending reasonable options for aligning production to markets, (ii) creating effective value chains and (iii) assessing how this information is of benefit to those trained through the BPHs. This led to the development of a trainers' manual in value chain thinking to help the youth to take advantage of opportunities offered by lucrative vegetable value chains.

h) A project coordination committee (PCC), whose main mandate was to advise the project leader on project management and coordinate the taskforces, was formed at VINESA project inception in 2013. The PCC met at the inception of the project to develop the project's annual workplan for year one, at end of every project year (2014-2016) to review progress, and at the end of the project (2017) to evaluate project's outcomes and impacts. In addition the PCC met between the years to assess progress as need arose. WorlVeg took the lead and worked with the NARS partners to set-up and operationalize the three taskforces as well as convene PCC meetings.

6 Achievements against activities and outputs/milestones

Objective 1: To Identify, test and promote crop management and crop protection technologies and practices for increased and safer production of vegetables

No.	Activity	Outputs/ Milestones	Due date of output/ milestone	Status (% achievement, and reasons for less than 100% achievement)
1.1	Undertake system characterization studies of the physical (e.g. soil, water, climate) and biological (pests, diseases and weeds) environments at each BPH site (to investigate constraints for veg production - how do they do it today and why is it not working/working?)	Report on vegetable cropping systems, current crop management practices, major production constraints, and possible solutions in targeted areas produced (PCs)	March 2016	**100% achieved** ▪ Baseline and endline surveys have been conducted in the 4 VINESA countries (Macharia et al., 2016). ▪ Report on cropping systems, management of postharvest losses, major production constraints, diet diversity and gender indicators has been compiled and distributed (Macharia et al., 2016 c). ▪ Training of youth at BPHs has been delivered to help the youth overcome these biotic and abiotic constraints. ▪ Farmers have been trained on use of drip irrigation and screen houses for efficient use of irrigation water and growing their crops all the year round.
1.2	Test and disseminate integrated pest management (IPM) approaches for safer use of pesticides with a focus on host plant resistance and cultural methods	Safe vegetable pest IPM packages for targeted diseases and insect pests tested and validated for selected crops (PCs)	July 2016	**100% achieved** ▪ Curriculum for training farmers on best practices and technologies on how to produce more, safer and affordable vegetables have been developed. ▪ With support from AHR, training of validated IPM packages has taken place in all 4 countries. ▪ A fact sheet on control of white flies has been developed and distributed (Macharia et al,, 2016a) ▪ A video on IPM practices to control whiteflies in outdoor tomatoes has been developed and disseminated (https://avrdc.org/portfolio-items/controlling-whitefly-tomato/).

1.3	Evaluate soil physical, chemical and biological properties at each site and develop soil fertility programs that maximize crop productivity and quality in a sustainable, economically-viable cropping system	Best soil management practices to sustain soil fertility designed and evaluated (PCs)	June 2016	**100% achieved** ▪ Soil analysis has been done in the 4 BPHs. ▪ Crop nutrition packages have been developed and promoted among the 6 lots of farmer trainees across the 4 BPHs. ▪ With support from AHR, Standard Operating Procedures (SOPs) for the major crops have been developed and used by project staff to manage crop plots at the BPHs.
1.4	Evaluate existing microbial and pesticide contamination (type and level) in traditional and introduced vegetables in urban markets in the target cities (to identify ways of minimizing risks associated with the microbial/chemical contaminants)	Extent of microbial and pesticide residue contamination documented and options for farm-level mitigation identified in Tanzania Only (PCs)	June 2016	**75% achieved** ▪ 1 paper on risks from microbial contamination in 132 vegetable samples from 5 urban markets in Tanzania under review (Kinabo, et al, 2017, IJPTI). ▪ 1 member of project team from Tanzania is studying a PhD at NMUST on pesticide residues analysis and their risks to consumers' health.

AHR = Applied Horticultural Research, Australia; PCs = partner countries; Best Practice Hub = BPH; NMUST = Nelson Mandela University of Science and Technology; IJPTI = International Journal of Postharvest Technology and Innovation; IPM = Integrated Pest Management.

Objective 2: To identify, evaluate and deploy improved varieties and high quality seeds of selected vegetable crops

No.	Activity	Outputs/ Milestones	Due date of output/ milestone	Status
2.1	Identify and evaluate genetic materials (germplasm, populations, varieties, lines) for adaptation through multi-locational trials within target production basin of participating countries	Inventory of existing varieties in the target zones (from the national catalogue) documented (PCs)	June 2016	**100% achieved** ▪ An inventory of vegetable varieties in each hub conducted in 2015 was used by partners in selection of elite germplasm for evaluation at VINESA's BPHs in 2016 and 2017 (Dinssa and Macharia, 2016).
		At least 2 promising varieties or lines of each of 6 exotic and traditional vegetable species tested in target areas in each country (PCs)	June 2016	**100% achieved** ▪ For 4 years, 4 varieties and 12 lines of exotic and traditional vegetable crops based on their nutritional and local marketing potential have been tested, validated and promoted in each country.
2.2	Promote intake of selected global and traditional vegetables for their high nutrient content and health promoting properties	Consumption of traditional varieties of vegetables with superior nutritional and health promoting properties promoted in each country (PCs)	June 2016	**100% achieved** ▪ 625 seed kits containing seeds of amaranth, nightshade, cowpea and Ethiopian mustard were distributed to establish home and school gardens for promoting vegetable consumption. (https://avrdc.org/growing-cooking-vegetables-vinesa/). ▪ 5 field days were held where nutritional messages were passed to 659 (292 M/367 F) participants. ▪ 3 school garden demos were established in 3 primary schools, and have been attended by 280 (153 M/127 F) pupils, teachers and parents in Tanzania. ▪ 2 videos to promote intake of vegetables to increase dietary diversity have been produced and circulated. (https://avrdc.org/vinesa-project-diversifying-diets/). ▪ 481 (260 M/221 F) young farmers were trained at 4 BPHs in Ethiopia, Malawi, Mozambique and Tanzania on importance of vegetables and their families are now consuming more vegetables.

2.3	Adapt seed production and conservation protocols for the best varieties of selected vegetables to local conditions	Farmers equipped with seed production and preservation skills to produce local "quality declared seeds" in Ethiopia, Malawi and Mozambique	June 2016	**50% achieved** ▪ Training modules for training farmers on quality seed production and conservation used to train farmers in each country. ▪ Farmers in Tanzania has started using seed production protocols from VINESA to grow seeds for private companies (Kibo seeds and Alpha Seeds) ▪ In variation #2, QDS was replaced with farmers training on seed production, processing and storage.
2.4	Facilitate commercial seed production in the project target areas to ensure quality seed supply	Farmers use acquired skills to produce quality seeds in contractual agreements with private seed companies in Tanzania	December 2016	**25% achieved** ▪ This activity was meant for Tanzania only after project variation #2. ▪ Farmers in Tanzania have become preferred contract growers of seeds (African eggplant, nightshade and tomato) for private seed companies such as Kibo and Alpha Seed. ▪ These farmers are using protocols for quality seed production developed by VINESA (Dinssa et al., 2016)

PCs = partner countries, Plants materials from World Vegetable Center's Genebank - Tomato, sweet pepper, hot pepper, Chinese cabbage, Pakchoi, cucumber, onion, shallot, African nightshade, amaranth, okra, jute mallow, pumpkin, bitter guard, Ethiopian mustard, beet root, African eggplant.

Objective 3: To strengthen postharvest systems the potential and feasibility for value adding and processing will be assessed, especially looking at technologies for improved postharvest storage and more effective value chain relationships

No.	Activity	Outputs/ Milestones	Due date of output/ milestone	Status
3.1	Evaluate appropriate postharvest technologies (including handling, sanitizers processing and packaging) for selected vegetables to reduce losses, increase value-adding and improve quality out-turn (including nutritional and commercial	Benchmarking of postharvest technology conducted, existing postharvest technology experience & local indigenous knowledge reviewed (PCs)	June 2016	**100% achieved** ▪ 1 report compiled from a survey of existing knowledge and practices of smallholder producers and traders on postharvest handling, postharvest technologies and indigenous knowledge (Aloyce et al., 2016).
		Loss-reducing and value-adding options for packaging, processing, storage and transportation identified, adapted and advocated via succession of trainees (PCs)	December 2016	**75% achieved** ▪ In 4 years, 481 (260 M/221 F) project trainees were equipped with knowledge and skills to reduce postharvest losses. ▪ 4 ZECC and 4 solar driers have been set up in communities in Malawi and Tanzania for demonstration purposes.
3.2	Understand consumer preferences and alternative routes to market, and determine quality standards in order to provide new outlets for vegetable products from peri-urban farm enterprises	Consumer-directed profile for priority crops determined (PCs)	June 2016	**75% achieved** ▪ From surveys in Ethiopia, Malawi, Mozambique and Tanzania, key product attributes required by specific markets have been identified (BINDZU, 2016, Manjate, 2014; NIFAD 2016). These include produce free from disease or insect damage, lower pesticide use (Ethiopia), vegetables grown in protective structures (Tanzania), and greater reliability in terms of quantity to hotels and institutions (Malawi).

		Market understanding, value chain management and quality standards identified, refined and taught to trainees (PC)	December 2016	**75% achieved** ▪ In June 2016, LUANR, BINDZU and SUA did a market survey in Malawi, Mozambique and Tanzania using the 7 Step Guide of Connecting Farmers to New Markets where new market opportunities for farmers were identified (Macharia et al., 2017). ▪ In November 2016, 28 participants in Australia Awards in Africa Agribusiness Course where 1 VINESA staff participated, were trained on rapid analysis of the tomato processing value chain in Tanzania.
3.3	Identify opportunities for improving value chain performance downstream of production	Potential for small scale processing assessed and documented and relationship options for priority market chains developed (PCs)	December 2016	**50% achieved** ▪ 2 MSc theses passed in Kenya ("Analysis of factors influencing intake of Traditional African Vegetables" and "High value market opportunities for smallholder vegetable growers in Tanzania"). ▪ These studies identified recommendations for increasing intake of vegetables and income for farmers in study communities.
		Develop value chain management training materials and assignments suitable for each BHP location. Train the trainers.	December 2014	**100% achieved** ▪ Value chain thinking (VCT) trainers' manual was developed in 2013/14, revised in 2015/16 and published (Dent et al., 2017) VCT manual has been translated into local languages and used to train farmers at BPHs.
		Train the trainees	December 2016	**100% achieved** ▪ Value chain trainers have trained 6 lots of 481 (260M/221 F) youth trainees in the 4 countries on how to identify suitable markets and grow vegetables that meet required quality standards.

PCs = partner countries, LUANR = Lilongwe University of Agriculture and Natural Resources, SUA = Sokoine University of Agriculture, Tanzania, BINDZU = BINDZU Agribusiness Ltd, Mozambique, ZECC = zero energy cooling chambers.

Objective 4: To strengthen national vegetable research and development capacity and linkages

No.	Activity	Outputs/ Milestones	Due date of output/ milestone	Status
4.1	Set-up and operate BPHs to facilitate farmer education and access to research innovations	Curriculum of value chain management modules developed which can reflect local circumstances. Train-the-trainer programs developed, delivered and assessed (PCs, A)	June 2014	**100% achieved** ▪ 4 BPHs (one for each country) were set up in 2013 for increasing farmers' access to agricultural innovations. ▪ Protocols for setting up crop experiments and collecting data in the 4 BPHs developed, revised and used. ▪ 69 (36M/33F) trainers from 4 countries equipped with new skills, course manual and materials on value chain analysis ▪ 1 VCT trainers' manual has been developed and is being used by 4 BPHs to increase farmers' access to markets (Dent et al., 2017). ▪ SOPs on how to grow various crops have been developed and validated at the 4 BPHs.
		About 500 youth equipped with sound knowledge and skills for self-employment (PCs)	June 2017	**100% achieved** ▪ By 30 June 2017, 481 (260 M/221 F) young farmers were trained at 4 BPHs. ▪ 865 (433 M/432 F) farmers in communities around BPHs were trained by returning graduates on GAP and marketing.
		Evaluate and refine value chain management training course modules (PCs, A)	December 2016	**100% achieved** ▪ The "7 Step Guide to Connecting Farmers to New Vegetable Markets" was published as a tool to link farmers to suitable markets (Dent and Macharia 2017).
		BPHs operational guidelines and plans for handing over of the BPHs as training, research and education centers developed	July 2017	**100% achieved** ▪ Protocols for setting up experiments and SOPs for management of major crops at the BPOHs developed and validated. ▪ Renovation of 4 BPHs has taken place. ▪ MOUs for handing over the BPHs have been developed and signed. ▪ 4 BPHs handed over to stakeholders in June 2017.

4.2	Contribute to graduate training and capacity-building of key project personnel from the national agricultural research and extension systems to build capacities for vegetable R & D, possibly also including value chain management	4 MSc students from local universities in Malawi and Tanzania trained to undertake field research in a topic relevant to VINESA project	December 2017	**75% achieved** ▪ 2 MSc thesis submitted, examined and passed. ▪ 1 project staff from Tanzania is on a DAAD scholarship for a PhD study on microbial and pesticide contamination. ▪ 1 Mozambican project staff is doing MSc (soil nutrition) in Brazil.
		Exchange and attachment visits carried out for junior staff of participating NARES (PCs)	December 2016	**100% achieved** ▪ 2 technical staff from iDE visited WVC Tanzania in September 2016 to learn about effective management of BPHs. ▪ 1 project staff from Tanzania attended a 3-months' International Agribusiness Course at University of Queensland, Australia in Sept 2016. ▪ 28 participants in International Agribusiness course attended 1-week value chain analysis practicals in Tanzania in November 2016.
4.3	Enhance regional and international collaboration between NARS and IARCs through task-forces	Project inception and planning workshop held (PCs, A)	September 2013	**100% achieved** ▪ Inception workshop held.
		Regional task-forces set up (PCs, A)	September 2013	**100% achieved** ▪ 3 task forces (production, postharvest and nutrition, and policy and capacity building) set up and operational.
		Annual review and planning workshops held (PCs, A)	September 2014, 2015,2016	**100% achieved** ▪ Annual review and planning workshops for years 1, 2 and 3 held in Ethiopia, Malawi and Mozambique, respectively. ▪ 1 end of project review done in October 2016.
		Project close out workshop held (PC, A)	September 2017	**100 achieved** ▪ 4 project closing workshops in 4 countries held in June 2017.

PCs = partner countries, GAP = Good Agricultural Practices, A = Australia, IDE = International Development Enterprises, Ethiopia, SOPs = Standard Operational Procedures, WVC = World Vegetable Center, DAAD = German Academic Exchange Service

7 Key results and discussion

The project team in conjunction with the three task forces (Production, Postharvest and Nutrition, and Policy and Capacity Building) together with project consultants (Value chains, Gender and Human Nutrition) carried out a number of research, training and capacity building activities to address the various research question listed in Section 4. Several manuscripts have also been compiled and are at various stages of publication as shown in Section 10.2. Summary of overview, key findings, and conclusions and recommendations from this work have been outlined in the following sections but does not include theoretical frameworks, model specifications and variables of analyses.

a) Consumers' Nutritional Knowledge and Its Effect on Intake of Traditional African Vegetables (TAVs) in Tanzania (Kavoi et al., 2017)

Study Overview

Indigenous and Traditional African Vegetables (TAVs) have received increasing attention from researchers, development agents and the public due to their significant contribution to food, nutrition security and enhanced livelihoods in Sub-Saharan Africa (Weinberger and Msuya, 2004). These vegetables, sometimes called indigenous vegetables, are an important source of nutrients in human diet, being excellent sources of vitamins A, B complex, C and E as well as iron and calcium (Yang and Keding, 2012). However, vegetable consumption is still very low in sub-Saharan Africa; far below the World Health Organization and Food and Agriculture Organization recommended daily intake of 200 grams per person (FAO, 2003). This low vegetable consumption is a major cause of vitamins and micronutrient deficiencies and other nutritional disorders especially among the low-income and food insecure populations. This study explored the factors that determine the nutrition knowledge, frequency intake and attitudes of consumers towards TAVs consumption. Generalized Poisson (Consul and Famoye, 1992) and factor analysis (Leech et al., 2012) were used to analyse data from randomly selected 65 respondents in Arumeru District, Arusha, Tanzania in July - November 2016.

Key findings

i) Factors affecting respondents' nutritional knowledge

Knowledge about nutritional value of TAVs was counted using a range from zero to five. Respondents were asked five questions to assess their nutrition knowledge and scores from each case were added together. Nutritional knowledge of respondents was influenced positively by age, number of years of schooling, annual income, household size and interactions between their age and income, education and annual income, and age and household size (Table 1).

Age of the respondent significantly influenced ($P<0.05$) nutritional knowledge. This meant that the older one gets, the more nutritional knowledge one accrues. Thus, younger consumers would be expected to possess relatively little nutritional knowledge, which should ultimately increase with age. The results also showed that years of schooling significantly ($P<0.01$) influenced awareness of nutritional knowledge. The more years spent in school by the respondent the more likely that he/she is more aware of nutritional importance of TAVs as compared to those who spent fewer years.

Table 1: Factors that influence consumers' nutritional knowledge

Dependent variable = Number of Nutrition knowledge known	Standard Poisson		Generalized Poisson	
	IRR	**P-values**	**IRR**	**P-values**
Gender	1.05	0.71	1.13	0.42
Ln of Years of schooling	0.000013	0.018***	3.67e-06	0.005***
Ln of Age	4.54e-06	0.058**	1.60e-06	0.02**
Occupation	1.01	0.82	1.03	0.58
Ln of Income	0.06	0.020**	0.05	0.005***
Group membership	1.06	0.66	1.09	0.40
Ln of Household size	0.06	0.14	0.07	0.07*
Ln Age &ln Income	2.11	0.082*	2.31	0.03**
Ln Yrs. in school & ln Income	2.27	0.016*	2.48	0.005***
Ln Age & Ln HH size	5.22	0.20	5.02	0.11
Constant	1.89e+18	0.011	1.15e+20	0.003
Number of observations	64		64	
Wald chi2(10)	18.86		19.07	
Prob>chi2	0.04		0.04	
Pseudo R2	0.02		0.04	

, ** and * denote significance level (p-values) at 10, 5 and 1 percent respectively, IRR = Internal rate of return*

This shows that education plays an important role in increasing awareness of nutritional value of vegetables. Annual income of the respondent significantly (P<0.01) influenced their nutritional knowledge for traders. Thus, respondents with higher incomes are likely to acquire more nutritional information than the lower income counterparts. Household size also significantly (P<0.1) influenced awareness of nutritional knowledge. With increase in the size of household, the incidence rate for awareness of nutritional value of TAVs would be expected to change by a factor of 0.07, while holding all other variables constant.

ii) Factors affecting the frequency of intake of traditional African vegetables (TAVs)

This section presents the results of the factors that influence the frequency intake of TAVs among consumers. The results of the Generalized Poisson regression model are shown in Table 2. Years of schooling significantly (P<0.1) influenced frequency intake of TAVs. The more the number of years spent in school by the respondent the more likely that he/she will consume more of TAVs. This showed that education plays a crucial role in sourcing and accessing nutritional knowledge which is likely to translate into improved consumption of these vegetables. Occupation of the respondent significantly (P<0.05) influenced frequency of TAVs intake. The incidence rate ratio for frequency intake changed by a

factor of 0.87, implying that respondents without occupational training on nutrition or agriculture had 13% less frequency of TAVs consumption compared to those who have.

Table 2: Factors which influence respondents' frequency of TAVs intake.

	Standard Poisson		**Generalized Poisson**	
Dependent variable = Intake frequency	**IRR**	**P-values**	**IRR**	**P-values**
Gender	1.13	0.46	1.50	0.30
Education	0.80	0.04**	0.72	0.09*
Ln of Age	0.92	0.79	0.91	0.77
Occupation	0.94	0.30	0.87	0.05**
Ln of Income	1.09	0.60	1.05	0.60
Ln of household size	1.46	0.12	1.99	0.01**
Member of group/social	0.96	0.74	0.838	0.18
Medicinal value	1.22	0.29	1.29	0.22
Ln of TAVs Weekly spent	1.09	0.18	1.10	0.19
Nutrition value	1.41	0.10	1.62	0.04**
Time to prepare	1.22	0.17	1.39	0.04**
Constant	0.19	0.20	0.05	0.06
Number of observations	65		65	
Wald chi2(13)	138.01		114.05	
Prob>chi2	0.00		0.00	
Pseudo R2	0.02		0.03	

** and ** denote significance level (p-values) at 10 and 5 percent respectively, IRR = Internal rate of return*

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Household size significantly (P<0.05) influenced frequency intake of TAVs. If the size of the household increases by one individual, the incidence rate ratio for frequency intake of TAVs changed by a factor of 1.99, while holding all other variables in the model constant. The bigger the household size, the higher the frequency of consuming TAVs. The frequency of TAVs intake was significantly (P<0.05) influenced by nutritional value perception of respondents. The incidence rate ratio for frequency intake changed by a factor of 1.62 or increased by 62% when the respondent consumed TAVs for nutritional purposes. The time spent to prepare TAVs also significantly (P<0.05) influenced the frequency of TAVs consumption. Less time spent preparing TAVs increases the incidence rate ration by a factor of 1.39, i.e. approximately 39%.

iii) Attitude towards consumption of Traditional African Vegetables (TAVs)

Factor analysis was used to identify latent dimensions underlying the different variables that measured traders' attitudes (Leech et al., 2012). Responses to the five-point Likert-type scale items were subjected to principal component factor analysis. Factor analysis was used to create measurement scale from exploratory factors using Varimax rotation (Kim and Mueller, 1978). The objective was to obtain fewer dimensions that reflected the relationships among these inter-related variables. An Eigen-value>1 rule was applied to identify the number of factors to extract. The variables that had large loadings on the same factors were grouped together. Factor loadings value of 0.50 and above is normally considered good and significant (George and Mallery, 2003). The analysis produced five factors that accounted for 75% of the total explained variance as shown in Table 3. The Kaiser's overall measure of sampling adequacy obtained was 0.69, which borders on the recommended threshold of 0.7 suggesting that the data is appropriate for factor analysis.

Table 3: Results of exploratory factor analysis.

Factor and item description	Factor loading	% variance explained
Factor 1: Health benefits		32.38
Fresh TAVs contain more nutrients than dried ones	0.84	
Intake of TAVs variety each day guarantee vitamins and minerals required	0.92	
It is important to choose diet accompanied with TAVs	0.72	
Consumption of TAVs improve eyesight and boost body immunity	0.87	
TAVs are best consumed when fresh	0.84	
Factor 2: Personal taste		20.78
TAVs are inferior foods (poverty food)	0.66	
TAVs are tasteless and bitter	0.88	
Factor 3: Time factor		10.84
TAVs takes more time to prepare	0.94	
Factor 4: Personal perception		10.48
TAVs are not good to me	0.97	

Source: survey of TAVs consumers in Arumeru District, July to November 2016.

Five attitude variables concerning importance of consuming TAVs varieties were loaded on Factor 1 with the cross-correlation coefficients of 0.84, 0.92, 0.72, 0.87, and 0.84, respectively. This factor accounted for 32.38% of the total variance and was termed '*Health Benefits*' because these variables focused mainly on the importance of consuming TAVs by local traders. Higher scores and positive responses on this factor implied a general understanding among traders and the significance of consuming traditional African vegetables. Factor 2 had cross-correlation coefficients of 0.66 and 0.88. Since these variables focused mainly on taste towards TAVs varieties; factor 2 was labelled '*Personal Taste*' and accounted for 20.78% of the total variance. These scores and the positive responses on this factor emphasize an important consumers' opinion on the taste of TAVs.

Preparation time for TAVs was loaded on factor 3 with cross-correlation coefficients of 0.94. This attribute focused on time taken to prepare TAVs, therefore Factor 3 was termed '*Time Factor'*. Peri-urban consumers normally have very limited time to prepare TAVs. Hence, TAVs traders usually prepare and pack them, then sell to consumers already prepared and ready for cooking. Time factor accounted for 10.8% of the total variance. Factor 4 had cross correlation coefficient of 0.96. This variable was labelled '*Personal Perception'* and it accounted for 10.48% of the total variance. The negative perception that TAVs are generally not good was also found, and it has been in the communities for years, causing some hindrances in consumption. The cumulative percent of variance for all the factors explained 74.47% of the total variance.

Conclusion and recommendations

Results from this study showed that number of years of schooling, age of the respondent and annual income influenced consumers' nutritional knowledge. Factors which influence consumers' intake frequency of TAVs are education, household size, occupation, nutritional value and time to prepare TAVs. Factor analysis results indicated that health, taste, time to prepare and perception significantly influenced the consumption of TAVs. These findings imply that consumption of TAVs can be enhanced by educating value chain players (including farmers, traders and consumers) on nutritional and health benefits of TAVs. There is also a need to train these players on preparation techniques so as to preserve vegetables' nutritional value and taste. The study recommends inclusion of health values of TAVs in 'eat-more vegetables" campaigns.

b) Connecting Farmers to High Value Markets: A Case Study of Smallholder Vegetable Growers in Ntcheu District, Malawi (Macharia, et al,. 2016)

Study Overview

One of the critical challenges facing vegetable smallholders in sub-Saharan Africa is a lack of understanding about quality specifications, volumes and service standards required to supply emerging lucrative urban markets, especially supermarkets, green groceries and tourist hotels (Neven and Reardon, 2004). Similarly, urban retailers report that unreliable quality, volume and delivery from local suppliers has driven them towards importing vegetables from large-scale farmers in countries such as South Africa (Weatherspoon and Reardon, 2002). This paper presents results from a case study on rapid value chain analysis conducted in Ntcheu District, Malawi between November 2015 and February 2016 using a new seven-step analytical tool (Dent and Macharia, 2017). The aim was to identify specific vegetable markets in Lilongwe, and smallholders' suitability to supply those markets. By aligning findings on market characteristics and farmers' strengths and weaknesses, action plans could be developed based on farmers' skills, attitudes and resources. Data on the structure and operations of selected vegetable value chains were collected through review of secondary documents, key informant interviews, focus group discussions, chain mapping and individual farmer interviews. The resulting action plans set out collective production and marketing strategies to enable farmers to compete in the marketplace on the quality of their vegetables rather than on price alone, thereby benefiting from higher value vegetable chains. The seven step analytical process could be readily adapted to the analysis of other commodity value chains.

Key findings

i) Potential market opportunities

Value chain mapping involved a combination of a physical walk from the end (consumption point) to the origin of the chain (inputs point) while interviewing key

members along the value chain (Fearne and Hughes, 1999). Mapping helps to identify discrete activities that constitute the core processes in a chain. Figure 2 illustrates the key players, flow of vegetables and important linkages in a typical vegetable value chain in Ntcheu District.

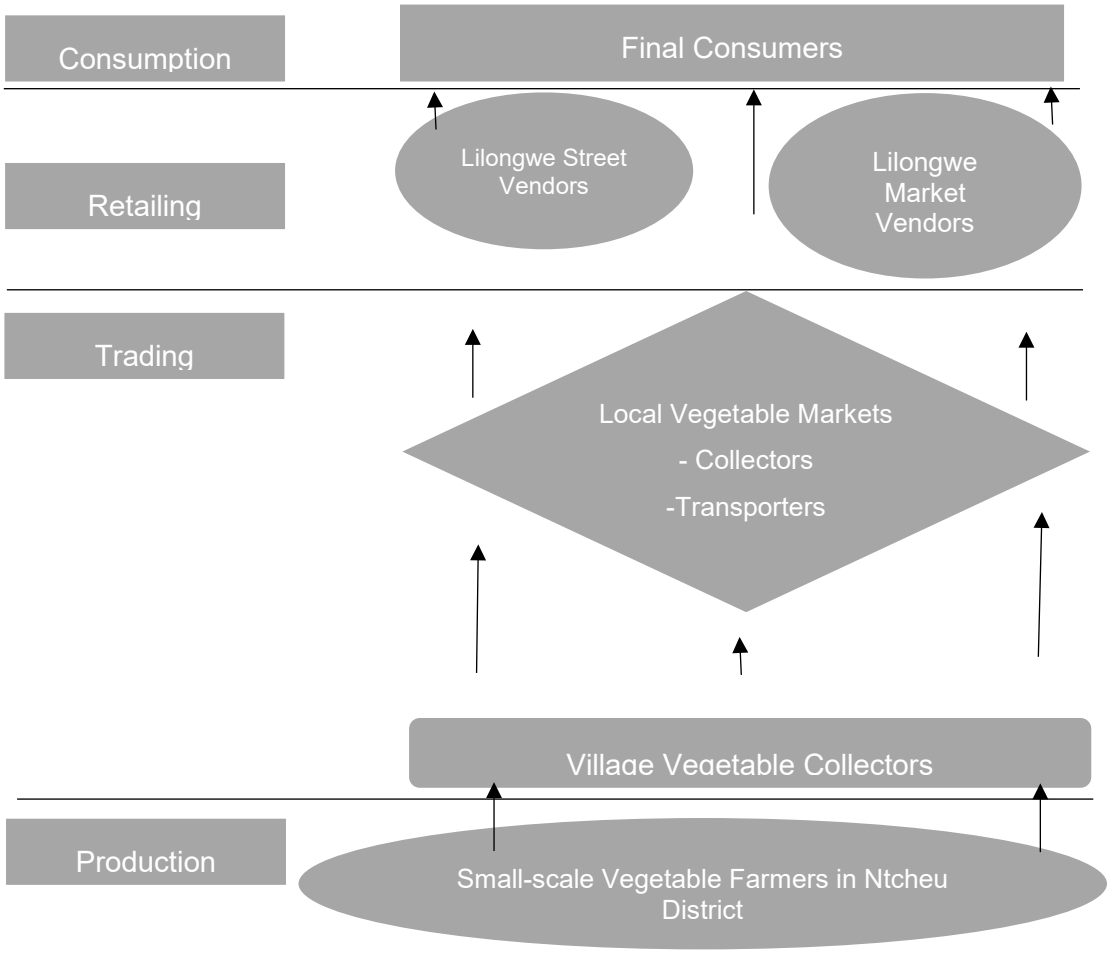

Figure 2: Flow of Vegetables from Ntcheu to Lilongwe (Adapted from Chagomoka et al., 2014)

Results showed that most of the vegetables sold in markets in Lilongwe are produced from within Malawi, including Ntcheu District (Chagomoka et al., 2014). At the village level, traders buy vegetables from farmers at farm gate prices. They then sell at local village markets at a relatively higher price to intermediate traders who are assemblers with more funds and capacity for bulking larger quantities. In turn, these traders ship the commodities to sell directly to markets in Lilongwe. Here, the traders sell to other traders in urban produce markets or to grocery shops that in turn sell to the final consumers.

Urban produce markets and retail shops in Lilongwe are consumers' main sources of vegetables where vegetable ownership may change hands two or three times before reaching urban retail shops, with each new owner taking a small mark-up in price. Vegetables are often transported to markets in open trucks, bicycles, oxcarts and baskets. Contrary to value chain thinking, the normal practice in a supply chain is where farmers increase the supply of low value vegetables into a local market inevitably leading to lower prices (Dent and Macharia, 2017).

However, farmers could work together to supply vegetables to lucrative markets in Malawi if they do so in a consistent way. There is a high demand, hence premium prices, of vegetables like broccoli, cauliflower, and amaranth, mostly due to their seasonal production (Chagomoka et al., 2014). This fact is confirmed by findings in Figure 3 (below)

which shows the level of consistency in the supply of selected vegetables in Lilongwe. About 60%, 30% and 20% of the respondents experience significant problems with the amaranth, cauliflower and broccoli that they buy, respectively. This could be a huge opportunity for smallholder vegetable farmers if they used high quality seeds and acquired skills to produce more nutritious, higher yielding and fresher vegetables.

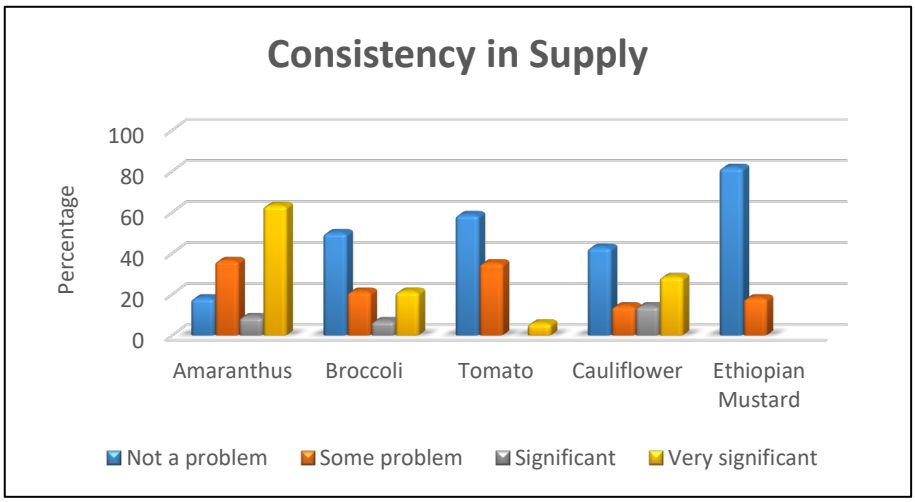

Figure 3: Overview of consistency in supplying vegetables to urban markets

ii) Farmers' strengths and limitations

A SWOT[1] analysis revealed farmers' strengths and limitations. Farmers had acquired skills from VINESA project on modern production techniques and postharvest handling, which could be used to add value and prolong shelf life. This creates an opportunity for farmers to form producer groups and thus build their capacity to produce high quality vegetables that could satisfy demand for vegetables in urban markets in Lilongwe. Figure 4 shows the various vegetables grown by farmers in Ntcheu for sale in urban markets in Lilongwe, with the three most commonly grown being Ethiopian mustard (41), rape (28), and tomato (35). However, vegetables that are rarely grown, and thus provide unique opportunities, included carrots, pumpkin leaves, and okra, while amaranth and Irish potato were rarely grown.

[1] SWOT = Strengths, Weaknesses, Opportunities and Threats

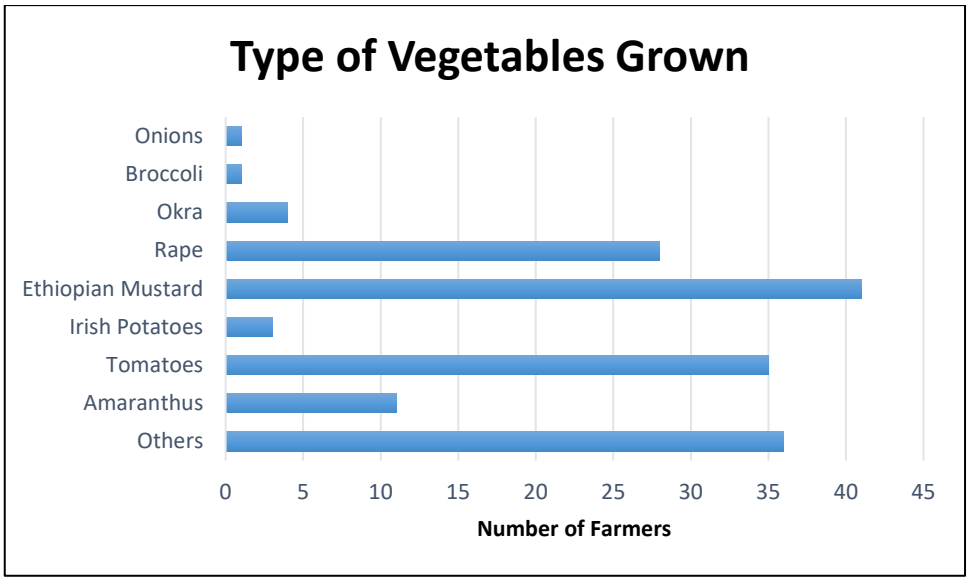

Figure 4: Type of vegetables grown in Ntecheu District

One of the major barrier to farmers' participation and benefiting from high value markets is their lack of information on real-time produce prices, supply and demand (Chagomoka et al., 2014). Asymmetric flow of information puts small vegetable farmers at a disadvantage, as they are unaware of the quality required by the market, and do not know the prices prevailing at different levels of the marketing chain. They thus accept any price being offered without considering the quality of their produce or their skills to produce these vegetables. To overcome these shortcomings, farmers must invest in market research, and good bookkeeping practices. Access to market information can empower farmers with a more accurate perception of what quality and quantity of a given vegetable, its demand and price, therefore avoiding exploitation by market intermediaries. This problem can be lessened by formation of farmer organisations to improve access to reliable market information.

iii) Cultivating collaborative behaviour to meet suppliers' demands

Most farmers in Ntcheu District did not know the needs of markets, other customers and end consumers in terms of types and volumes of vegetables required. If they did, then they would devote all their resources (land, labor, capital) to producing and supplying vegetables that meet these needs on a continuous basis (Collins., 2009). VINESA trained its farmers on the need to change their behavior of competing with each other on price and instead compete on the quality of the produce they supply. Working in groups rather than individually makes it easier to produce and supply to a particular market. This approach creates favorable conditions for mutual trust among value chain players, sharing of market information freely, sharing of skills, resources and technologies, and increasing their ability to respond to changing market and consumer demands (Macharia et al., 2013). The overall effect would be an increase in efficiency, flexibility and increased incomes due to reduced costs of production from economies of scale.

Conclusion and recommendations

This case study presented potential market opportunities in Lilongwe, Malawi that small-scale vegetable farmers can pursue. Critical challenges preventing these farmers from targeting and supplying vegetables to these markets were identified and analysed. Overall, lucrative markets exist for different vegetables in Lilongwe. Small-scale farmers have the production capacity to supply to some of these markets; however, they must work collectively in groups to meet the demand for high quality vegetables, timely delivery, and consistency in supply these markets require. Understanding the needs and wants of markets, other customers, and end consumers, as derived from use of the "7 Step Guide to Connecting Farmers to New Vegetable Markets" (Dent, at al, 2017) developed by

VINESA project and as outlined in this study, could help groups of small-scale farmers convert themselves from common subsistence farmers to become preferred suppliers who can provide vegetables that consistently meet market needs for quality, volume and delivery. This practice could lead to win-win situations for farmers, traders, and consumers of fresh vegetables in peri-urban and urban settings.

c) Microbial Contamination of Vegetables Sold in Urban Markets in Tanzania (Kinabo, et al., 2017)

Study Overview

Vegetables provide essential vitamins, micronutrients, phytochemicals and dietary fibre to nourish the body and boost its immune system (Suruchi and Pankaj, 2011). However, due to their perishable nature, vegetables are subjected to microbial contamination during production, transportation and handling (Scallan et al., 2011). Using the Food and Drug Administration (2003) microbial analysis protocols, this study evaluated microbial load of fresh vegetables from different markets in Arusha, Tanzania. From 130 randomly collected vegetable samples, 90%, 74% and 8% of these were contaminated with coliform bacteria, *Escherichia coli* and *Esc[2]herichia coli* 0157:H7 respectively. Total bacteria count (TBC) was greater than 4 $\log_{10}$ CFU/g, which is above the allowable levels of less than 2 $\log_{10}$ CFU/g. *Escherichia coli* 0157:H7 should not be detected in human food. These findings indicate that hygienic practices are lacking during production, handling and marketing of vegetables in developing countries. Application of good agricultural and manufacturing practices along vegetable value chains could increase consumers' confidence in the quality of vegetables they buy while producers would get more profit from increased sales.

Key findings

i) Types of microbial contaminants in fresh vegetables sold in urban markets

Salmonella spp. was not isolated in all of the samples. There was no statistical difference in microbial contamination among leafy and non-leafy vegetables (Table 4 and Figure 5). However, the level of total coliform (TC) (t (22) = 50.34, P = 0.005) and total bacteria count (TBC) (t^3 (22) = 0.19, P = 0. 009) was higher in leafy vegetables (4.85 $\pm$ 0.52 log CFU/g sample) and non-leafy vegetables (5.26 $\pm$ 0.28 log CFU/g sample) as compared to water used for irrigation, washing and sprinkling (3.05 $\pm$ 2.38 and 4.85 $\pm$ 0.36 log CFU/g sample).

Table 4: Population of total bacteria counts (TBC), total coliform (TC), *E. coli* and yeasts/molds[a] in leafy vegetables ($\log_{10}$ CFU per g)

Type of microbe	TBC	Min-Max	TC	Min-Max	E. coli	Min-Max	Yeast	Min-Max
Type of vegetable								
Chinese cabbage	5.31	4.79 - 5.65	5.09	4.23 - 5.65	5.48	0 - 4.52	4.13	4.72 - 5.65
African nightshade	5.09	5.24 - 5.36	4.63	4.89 - 5.27	4.08	4.49 - 4.84	3.78	4.18 - 4.66
Ethiopian mustard	5.04	5.24 - 5.52	4.00	4.79 - 5.28	2.76	1.81 - 3.7	4.27	4.57 - 5.01
Amaranth	4.81	5.14 - 5.65	4.00	4.48 - 5.1	3.02	2.56 - 3.48	3.98	4.42 - 4.79

[2] CFU = Coliform Forming Units
[3] t – stands for t-test statistical test

Cowpea	5.23	NA	4.89	NA	0	NA	4.31	NA
Kale	5.65	NA	5.48	NA	4.26	NA	5.48	NA

[a] = Mean, minimum and maximum values are in $\log_{10}$ CFU per g in the vegetable samples. N/A indicates not applicable because the samples were obtained from a single source.

The levels of TBC and TC were greater than 4 $\log_{10}$ CFU/g, which is regarded as unacceptable; their presence at such high levels suggests overall unhygienic standard of a food product. For a food product to be regarded as satisfactory, its bacteria/coliform counts should be less than 2 $\log_{10}$ CFU per g (HPA, 2009) and human pathogens like *E. coli* 0157:H7 should not be detected. Their presence in food products may render the food unfit for human consumption as they pose high health risks to consumers. All types of leafy vegetables had high levels of TBC and TC.

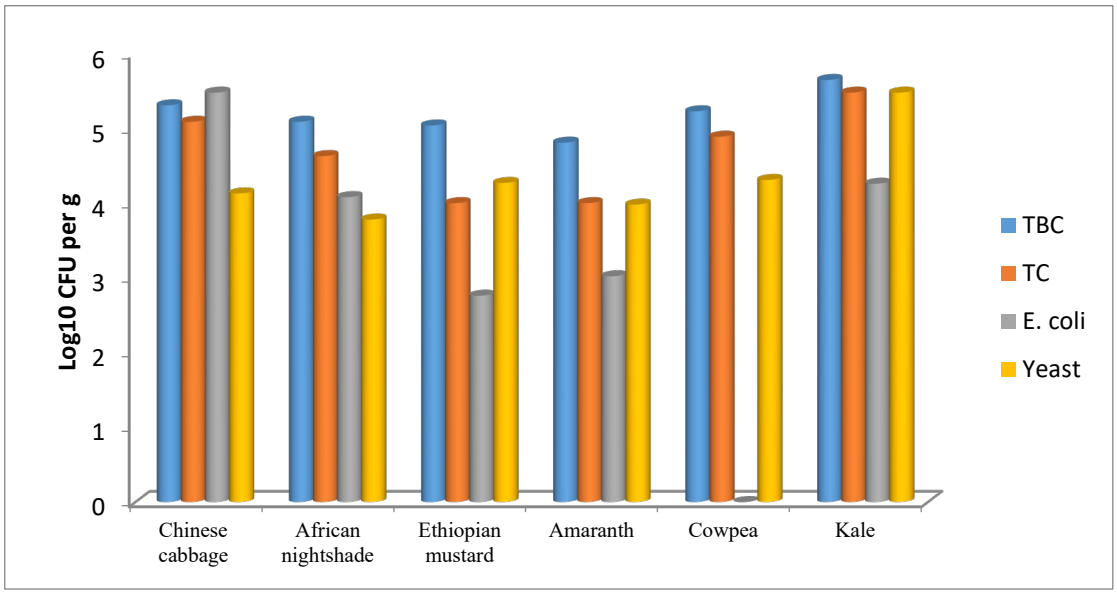

Figure 5: Level of microbial contamination in various leafy vegetable samples collected from four different markets and one production site

ii) Contamination across different vegetables

The level of *E. coli* was highest in Chinese cabbage than in other vegetables, followed by Ethiopian mustard (kale) and African nightshade. The level of contamination with yeast was higher in kale than in other vegetables, which seemed to have more or less the same level of contamination (Table 5 and Figure 6). All non-leafy vegetable samples collected were contaminated with microorganisms as depicted by high levels of TBC, TC, *E. coli* and yeast. *E. coli* also was an important microbial contaminant in carrots and African eggplant, but was not detected in green beans. The water samples contained high levels of TBC (4.85), TC (3.08), yeast (3.48) and *E. coli* in CFU/g. Presence of high levels of *E. coli* in most vegetables could be due to the untreated waste water used for irrigation in urban plots as well as cross contamination between different vegetables during handling and washing of vegetables with contaminated water at the market places.

Table 5: Population of total bacteria counts (TBC), total coliform (TC), *E. Coli* and yeasts/mould[s] in non-leafy vegetables and water samples ($\log_{10}$ CFU per g).

Type of microbe	TBC	Min-Max	TC	Min-Max	E. coli	Min-Max	Yeast	Min-Max
Type of vegetable								
Tomato	5.10	4.04 - 5.65	4.53	3.48 - 5.56	1.50	*ND* - 4.04	4.35	3.0 – 4.9
Carrot	5.61	5.49 - 5.65	5.56	5.36 - 5.65	4.09	3.48 - 4.58	4.78	4.11- 5.48
African eggplant	5.37	4.96 - 5.65	5.17	4.87 - 5.65	4.15	4.08 - 4.27	4.42	4.23 - 4.63
Green beans	5.23	NA	4.65	NA	ND	NA	4.28	NA
Water	4.85	4.30 - 5.35	3.05	ND - 5.16	1.46	ND - 4.68	3.48	ND - 5.04

[a] = Mean, minimum and maximum values are in $\log_{10}$ CFU per g in vegetable samples. N/A indicates not applicable because the samples were obtained from a single source, TBC = Total Bacteria Counts.

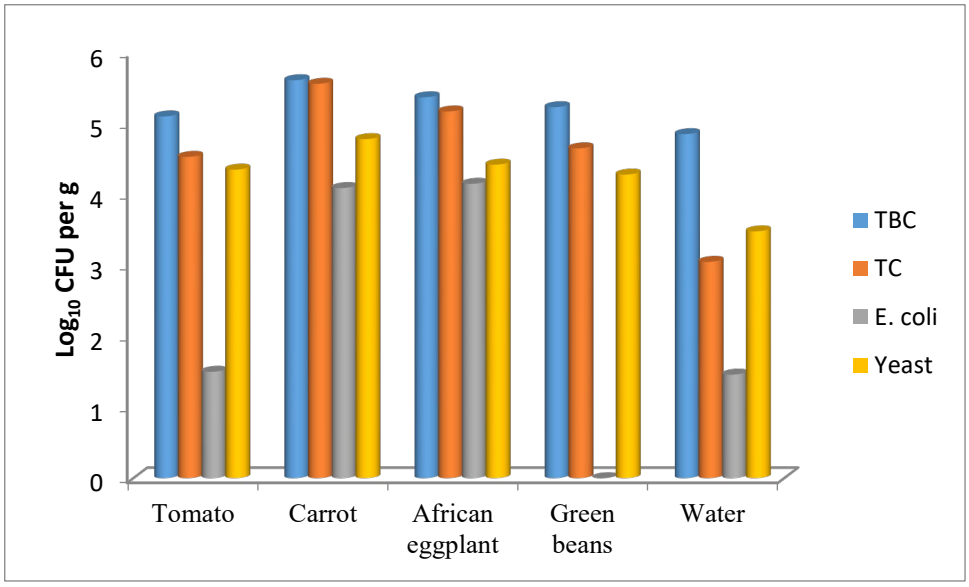

Figure 6: Level of microbial contamination in various non-leafy vegetable and water samples collected from four different markets and one production site

iii) Contamination across different markets

The location of the market was slightly to moderately associated with the concentration of Total Bacteria Count (r_s= 0.42, *P* = 0. 009x), Total coliform count (r_s= 0.44, *P* = 0. 007x) and *E. coli* (r_s= 0.42, *P* = 0. 001x). In all cases (Table 6 and Figure 7), vegetables and water samples obtained from urban markets had the highest mean concentration of Total Bacteria Count (TBC), Total Coliform (TC) and *E. coli*, (5.35 ± 0.29, 4.94 ± 0.59, 3.46 ± 1.50) followed by peri-urban markets (5.14 ± 0.39, 4.82 ± 0.52, 2.23 ± 2.13). The vegetable and water samples obtained on the WorldVeg farm had the lowest mean concentration (4.94 ± 0.54, 3.37 ± 2.38 and 0.69 ± 1.82).

Table 6: Concentration of total coliform (TC) from different market locations ($\log_{10}$ CFU/g).

Total coliform(TC)				
Location of the market	**Mean**	**SD**	**Minimum**	**Maximum**
Urban	4.94	0.59	3.78	5.65
Peri-urban	4.82	0.52	4.23	5.65
Farm	3.37	2.38	0	5.28
Concentration of *E. coli* [a]				
Location of the market	**Mean**	**S.D**	**Minimum**	**Maximum**
Urban	3.46	1.5	0	4.68
Peri-urban	2.23	2.13	0	4.26
Farm	0.69	1.83	0	4.84

[a] = Mean, minimum, and maximum values are in $\log_{10}$ CFU per g in the vegetable samples, SD = Standard deviation, N/A indicates not applicable because the samples were obtained from a single source.

E. coli concentration was significantly different among various markets (F^{4} (4)=3.88, *P*=.011). Vegetables and water samples obtained from the World Vegetable Center farm had the lowest mean *E. coli* concentration; however, the highest *E. coli* concentration (M=4.84, SD= 1.84) was found in African nightshade grown at the Center. Kilombero, Nakumatt Supermarket and Soko Kuu had the highest mean concentration of *E. coli* (Table 6 and Figure 3). Similarly, the same markets had high levels of TBC, TC and yeast.

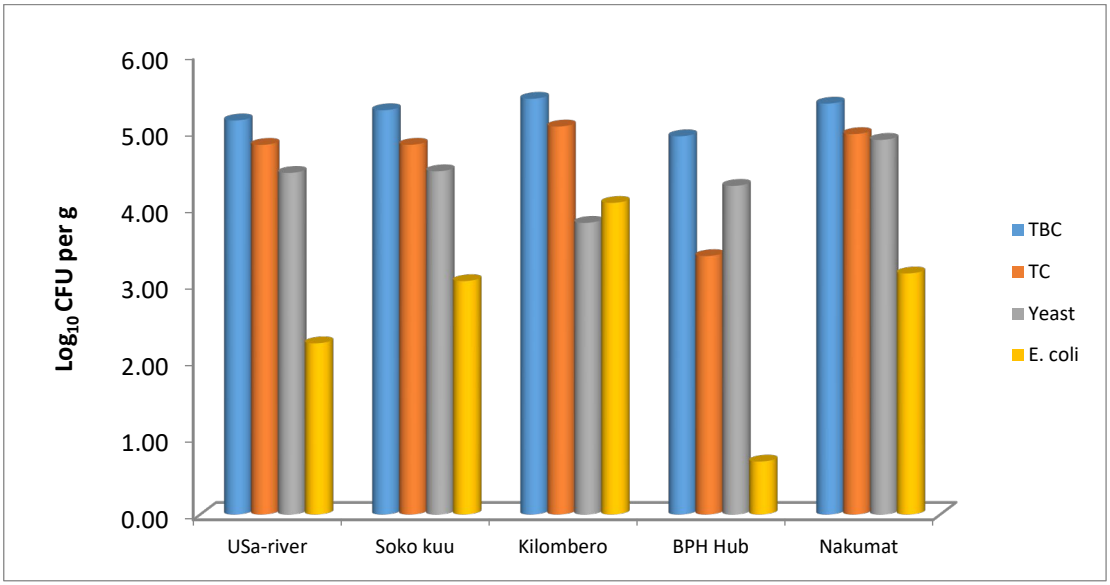

Figure 7: Level of microbial contamination from four different market sites

Conclusion and recommendations

[4] *F- stands for ANOVA (Analysis of Variance) statistical test*

This study's preliminary findings provides a basis for further assessment of food safety issues in fresh vegetables including types and levels of pesticide residues found in fresh vegetables sold at urban markets in developing countries. There is a need for a systematic approach to apply good agricultural practices (GAP) and hazard analysis of critical control points (HACCP) in all aspects of production, processing, distribution, and sale of vegetables to reduce microbial contamination of fresh produce sold in urban markets. Food safety education should be provided to vegetable handlers about the proper storage, handling and sanitation of vegetables to help minimize levels of microbial contamination. Effective temperature control measures such as the use of cool rooms for storage, refrigeration during transport, and cooling during the final display at the market place are important practices for reducing contamination. Appropriate and supportive food safety policies are required at all stages of the vegetable value chain while market infrastructures should be improved to provide healthy, contaminant-free fresh produce to consumers.

d) Integrating Gender in Research and Development Projects: A Case Study of Vegetable BPHs in Ethiopia, Malawi, Mozambique and Tanzania (Ghamunga and Macharia, 2017)

Study Overview

Although women contribute more than 70 percent of agricultural production in sub-Saharan Africa, their contribution is often less visible (WFP/FAO, 2009). Most projects designed to support them fail to consider the different roles of men and women, as well as the underlying gender fabric that determines how agricultural production occurs (Kabeer, 2003). This case study that was carried out in Ethiopia, Malawi and Tanzania in January - June 2016 increases an understanding of gender constraints that limit women participation in agricultural projects in developing countries. Its aim was to identify gender roles and division of labor and assess how these affects decision making in vegetable value chains. Focus group discussions were used to capture perceptions of male and female farmers, who were trained at VINESA's BPHs in four countries, on gender roles, needs and constraints they face. Thematic findings from 258 respondents (68% men, 32% women) indicated that, there is a significant gender awareness among the project staff, farmers and the communities. It is also noted that both men and women are working together to improve household income and nutrition. However, gender stereotypes within communities still exist and undermine gender inclusivity in market-oriented vegetable farming.

Key findings

i) Gender roles and division of labour in vegetable value chains

A typical value chain commonly addressed by agricultural projects includes three main processes - crop production, postharvest management and marketing (Dent, et al, 2017). The roles of men and women on who does what, where, when and how are culturally determined, though this can change with time and context. In this study, focus group discussions with farmers in the four countries showed that generally men and women share vegetable production roles such as land preparation, seedbed preparation, transplanting, cultivation, spraying, irrigation, harvesting and marketing at the BPHs (Table 7). However, when they returned back to their households, men and women assumed their traditional division of labor, such as cooking, fetching water, and bathing children while men got involved in activities such as fencing and attending community meetings.

Table 7: Tasks performed by different gender in vegetable value chains

GENDER ROLES	PRODUCTION		POSTHARVEST		MARKETING	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
Ethiopia	Ploughing, seedbed preparation, field preparation, transplanting, cultivation, irrigation, operating water pumps, harvesting, carry heavy loads during loading and unloading	seedbed preparation, field preparation, transplanting, cultivation, irrigation, harvesting,			marketing other types of vegetables like onions and tomatoes	marketing leafy vegetables for spouses
Malawi	land clearing, spraying, irrigating pushing treadle pump, pumping, harvesting,	sowing, irrigation of nursery seedlings			marketing vegetables apart from leafy vegetables	packing and marketing kale
Mozambique	land clearing, cultivation, sowing, pulverization, harvesting	land clearing, cultivation, sowing, harvesting			marketing	marketing
Tanzania	spraying, structure construction, cultivation, planting, weeding, irrigation harvesting	spraying, structure construction, cultivation, planting, weeding, irrigation, harvesting				

ii) Women involvement in decision making in vegetable value chains

An understanding of household decision making enables development agents to identify who is ultimately benefitting from a development intervention in a community. Traditionally, women are often excluded from household and community decision-making processes (Cotula, 2002). Results of the focus groups on decision making at household and community levels (Text Box 1) show that, in general, men as household heads make most of the decisions on allocation of household activities and also make all decisions at community level. Although some of VINESA countries have women as members of local committees, their presence seems to be more symbolic, or to fulfil either a government policy (Local government policy in Tanzania makes provisions for 33% representation of women at community level) or a project condition of including women in the project, as required by VINESA project. In Ethiopia, decision making at household level assumed a hierarchical structure, with the husband making all decisions, which are passed to the children through the mother, an indication of the man's control of household's labor of women and children. The implication is that vegetables, and by extension, income from labor of women and children on the farm are also controlled by men in male-headed households. Consequently, the household head determines the level of women's income and household nutrition. All the countries seem to maintain patriarchal decision making where male control of household labor, farm produce, and accrued benefits.

Text Box 1: Decision making in households around VINESA's BPHs

a) Ethiopia

- Often men allocate activities to the family.
- Women allocate activities to their children (boys and girls).
- Men allocate resources for crop production.
- Men consult their wives and children on what crops to grow and where to grow them.
- Women were limited to growing only kale and green pepper in the backyard.
- Currently, women are involved in production of other vegetable crops and able to irrigate these crops when their husbands are away.
- VINESA has contributed to increased consultation among family members.
- At community level, awareness to involve women is being raised, but practicality is limited.
- However, if women are willing to participate in community action planning, they are not prohibited.

b) Malawi

- No change has occurred on decisions at household and community level. Men make all decisions.

c) Mozambique

- No change has occurred on decisions at household and community level, but there is much more women's participation in action planning although the final decision is made by men.

d) Tanzania

- Allocation of activities is done with a common understanding between a man and his wife on who is to do what activities and when.
- No change in allocation of resources. The common practice is that resources such as land are allocated to a married son but not to the daughter.
- No change on community decision making as currently men make all decisions.

iii) Effects of training at VINESA's BPHs on households' income and nutrition

Income

Between 70 to 95% of all the vegetables grown in vegetable basins where the BPHs are located in all countries is sold for income, an indication of the expected VINESA impact on female and male farmers. In Tanzania, income from crops grown at the Madiira Farm's BPH and from the production of different kinds of vegetables on farmers' farms have increased household savings. Community leaders appreciated VINESA's new methods of growing vegetables to increase income for men, women and youth in the community. In some of the BPHs (Ethiopia, Malawi, Tanzania), farmers have established market linkages with supermarkets, hospitals and schools, thus having an assured market for their produce and a more constant flow of income.

Nutrition

Out of the total vegetables produced by households across countries, the proportion of vegetables consumed varied from one country to another (Table 8). It varied from 1% in Mozambique to 30% in Tanzania. Generally, there is evidence that some of the vegetables produced are consumed by families and this has some impact on their level of nutrition. It was reported in Ethiopia that men brought vegetables home from the BPH at Woliso and are producing and selling Ethiopian mustard (kale). Households' nutrition status has also improved, as various vegetables are being produced, and meals are thus diversified and improved as a result of better income from vegetable sales. Support of men to families to increase vegetable consumption is likely to improve households'' diet and nutritional status.

Table 8: Proportion of vegetables sold and consumed by BPH households

Country	Ethiopia	Malawi	Mozambique	Tanzania
Vegetables Consumed	5-10 %	10 %	1%	30 %
Vegetables Sold	90-95 %	90%	95 - 99 %	70 %

Conclusion and recommendation

The importance of gender integration in agricultural research and development projects, especially vegetable farming, cannot be underestimated. Integration of gender in VINESA, a donor funded project, was influenced by a number of factors. These include gender roles and division of labor that are determined by perceptions of femininity and masculinity in the types of vegetables to be produced and marketed by men and women; lack of a gender objective in the initial project stages; discriminative land systems that give preference to married males of the household and exclude daughters; lack of gender analytical skills by project staff; and biases perceptions of female traders. Despite these bottlenecks, the project has made several achievements, especially in gender sensitization of the project teams, who, after realising the need to involve women, increased the number of women trainees in successive training. Men and women have learned to share activities, a practice which is gradually being adopted by households and the communities around VINESA's BPHs. For example, in Ethiopia, there was only one woman in the first lot of trainees whereas there were 10 women in the third lot. The project impact on income and nutrition is very promising. With their acquired modern skills, farmers have high expectations and morale for achieving project and individual goals. Various strategies generated by different stakeholders and the best practices acquired from the BPHs demonstrate an increasing level of gender awareness as a result of project interventions in the BPH communities and a promising future for farmer trainees, men and women alike. This experience should not be limited to project countries only, but should be scaled out to other communities and countries within the Eastern and Southern African region.

8 Impacts

8.1 Scientific impacts – now and in 5 years

Since its inception in June 2013, VINEASA project has generated knowledge, transferred know-how, and helped to strengthen research-to-delivery capacity and linkages of its research and development partners in order to enhance the contribution of VINESA's outputs to households and communities' economic, social and environmental outcomes and impacts. The project has also developed various modules, guidelines and protocols that are gaining popularity among the national research institutions in the project's target countries of Ethiopia, Malawi, Mozambique and Tanzania. During end-of-project that was done by a private consultant in October 2017, VINESA's outcomes, impacts and learning processes were ranked as "Good Quality[5]" implying that performance was quite good while project team had delivered on the majority of the activities, with valid justifications for those that were not achieved (Hall, 2016).

Specifically, the emerging impacts from VINESA project have come as a result of the following adoption pathways:

a) technological interventions leading to increased productivity of the high value vegetable-based production systems and facilitated market access for competitive high quality products to increase household income of youth and women groups;
b) enhanced value chains that have helped farming households to produce and consume more nutritious and safer vegetables; and
c) educational and capacity building interventions targeting producers and vegetable value chain actors helping them integrate production of high value crops with meeting market needs, and development of enduring business relationships.

To bench mark various indicators that could be used to gauge the effectiveness of VINESA's BPHs (BPHs) in disseminating agricultural innovations and increasing the levels of knowledge for the youth, a baseline survey was conducted by World Vegetable Center's socio-economic team in Ethiopia, Malawi, Mozambique and Tanzania in March-June 2014. At close of the project, an endline survey of outputs, outcomes and impacts from three VINESA project countries was carried out, using propensity score matching (PSM), in Ethiopia, Malawi and Tanzania in March-June 2017 (Hirano and Imbens 2001). Mozambique was not included because of the small sample of direct beneficiaries (trained youths) at the time of survey since impact evaluation had be done at least six months after training in order to give meaningful impact of the project.

The PSM was used to estimate the impact of training on selected outcome indicators such as dietary diversity, input use and yield in Tanzania, Ethiopia and Malawi. The average treatment effect (ATE) was used to estimate the expected effect on the outcome in the whole population that average treatment effect on treated (ATT) that estimates the impact effects on target beneficiaries. Nearest neighbour matching was used to locate the farmers trained at VINESA's BPHs and matches these effects with the nearest non-trained farmer. The difference in outcome variables is calculated for each matched pair and then averaged over the entire sample to obtain the average treatment effect (ATE). The preliminary results showed that farmers in Ethiopia, Malawi and Tanzania who received training at VINESA's BPHs had significantly higher dietary diversity scores (1 more extra food group) than non-trained farmers (Table 9). Thus training helped to improve the dietary diversity of the households.

[5] Score 4 = 65-79%

VINESA farmers were also trained in IPM and relatively used less pesticide in vegetable production than the untrained farmers in same localities. This finding suggests that the IPM training improved the safe handling of pesticides by 9% in Ethiopia, 56% in Malawi and 30% among farmers in Tanzania. Among the indirect beneficiaries in Ethiopia, the training on IPM reduced usage of chemical pesticides by 63%. This means that training that aimed at imparting knowledge and skills on available IPM packages resulted into reduction in harmful pesticide use in vegetables and more biological and cultural means such as repellent crops, insect traps, and crop rotation were adopted by farmers.

Table 9: Average treatment effect of VINESA training on diet diversity, input use and yield

	Direct beneficiary versus Control					Indirect beneficiary versus Control				
Outcome indicators	ATE	SE	Test	PO mean	ATE as % of PO mean	ATE	SE	Test	PO mean	ATE as % of PO mean
Tanzania										
Dietary diversity score	0.75	0.25	***	6.66	11%	-0.40	0.18	**	6.98	-6%
Pesticides in kg per hectares	-4.96	2.54	*	16.62	-30%	-3.80	3.99	NS	16.06	-24%
Fertilizer in kg per hectares	3.61	56.08	NS	236.87	2%	-4.45	43.19	NS	219.61	-2%
Yield in Kg per hectares	694.09	1088.49	NS	5937.00	12%	52.92	911.47	NS	6043.09	1%
Ethiopia										
Dietary diversity score	0.88	0.31	***	5.64	16%	0.09	0.13	NS	5.43	2%
Pesticides in kg per hectares	-2.31	1.07	**	26.55	-9%	-1.79	18.97	NS	29.54	-6%
Fertilizer in kg per hectares	74.85	30.92	**	263.48	28%	52.07	98.02	NS	209.81	25%
Yield in Kg per hectares	365.46	1644.35	NS	4295.67	9%	437.87	788.17	NS	3545.18	12%
Malawi										
Dietary diversity score	0.56	0.25	**	5.70	9.7%	0.18	0.26	NS	6.13	3%
Pesticides in kg per hectares	-23.05	13.11	*	41.30	-55.8%	-20.89	10.18	**	32.90	-63%
Fertilizer in kg per hectares	94.57	54.39	*	241.00	39.2%	27.22	15.33	*	65.10	42%
Yield in Kg per hectares	1554.52	885.36	*	4934.10	31.5%	871.46	757.8	NS	5163.62	17%

Notes: *** denote the level of significance = p<0.01, ** p<0.05 and* p<0.10, NS=not significant; ATE = Average treatment effect. PO == Potential outcome mean (mean for the control group). SE=Standard errors.

Farmers' training helped to increase the fertilizer use by 28% (75Kg/ha more) for trained farmers in Ethiopia and 39% (94kg/ha more) in Malawi. However, this higher usage of fertilizers did not translate into significant increase in yield compared to untrained farmers in Ethiopia and Tanzania. The impact on yield was witnessed in Malawi where trained farmers produced 1555kg/ha more than the non-trained farmers. Nevertheless, as much as the impact on yield was not statistically significant at 10% significant level in Ethiopia and Malawi, the yield increased by 9% and17% for direct and indirect trained farmers respectively.

More data analysis is going on and findings will be published in a peer reviewed journal. However, some of the emerging impacts from the four VINESA's BPHs, and/or which will are anticipated in the next five years are outlined in the following sections:

a) VINESA's BPH approach is a new research-extension approach which is gaining popularity among scientists from other disciplines, institutions and projects. Four BPHs are serving as centers where young farmers, communities and stakeholders interact with traders and other chain players thereby increasing their skills and strengthening their working relationships (Annex 5). In Ethiopia, after annual research reviews (involving NARS, universities, government and NGOs), good agricultural packages which have been identified and validated at Wolisso's BPH have gained acceptance among scientists. This way, vegetables are becoming popular as a source of income and nutrition in the traditional *teff* district of Wolisso and its neighbouring districts.

b) Experimental protocols for fruit, leaf and bulb vegetable testing were developed and published by VINESA and HORTINLEA[6] projects to help stakeholders set up crop trials scientifically. Increase in use of these protocols by research institutions and teaching partners in Eastern and Southern Africa is expected to increase the contribution of vegetable research to nutrition, income and livelihood impacts in the region (http://avrdc.org/download/publications/from_the_field/protocols/International-Cooperators-Guide_rev1.pdf).

c) Vegetables are plagued by a vast number of insect pests, and their damage is in part increasing due to resistance build up due to indiscriminate use of common insecticides. For example, whiteflies (*Bemisia tabaci*) have drastically reduced yields in outdoor tomatoes in Tanzania. Packages on integrated pest management (IPM) control of pests (including cultural practices, resistant crop varieties, trap crops) have been developed. About 75% of returning graduates are adopting these practices leading to safer vegetables, more profits, and sustainable environments. From endline survey data, training on IPM practice has improved the safe handling of pesticides by 30% among farmers in Tanzania, 9% in Ethiopia and 56% in Malawi. VINESA has also developed a fact sheet and a video to train farmers on use of IPM practices to control whiteflies in outdoor tomatoes that is being used by VINESA as well as other farmers in project countries (https://avrdc.org/portfolio-items/controlling-whitefly-tomato/).

d) From our baseline survey in July 2014, use of hybrid vegetable seeds by farmer in the target districts in Ethiopia (Wolisso), Malawi (Ntcheu) and Tanzania (Arumeru) stood at 53%. During the last four years, VINESA has introduced over 64 elite germplasm with great potential to improve nutrition and market returns for farmers and their households. Selected vegetable germplasm from the World Vegetable Center have undergone multi-location testing by national vegetable improvement programs in respective countries. The elite germplasm has increased farmers' access to improved vegetable varieties (African nightshade, Ethiopian mustard, amaranth, African eggplant, bitter gourd, beetroot, sweet pepper, tomatoes, onions). According to an impact survey involving 1,112 respondents in March 2017, use of quality seeds among VINESA trained farmers in target districts now stands at 67%.

[6] *HORTINLEA = Horticultural Innovations and Learning for Improved Nutrition and Livelihood in East Africa.*

8.2 Capacity impacts – now and in 5 years

The following are observed capacity impacts in the four focus countries.

a) VINESA has establishment 4 BPHs in four countries as centers to facilitate farmers' education and access to research innovations. Operated by young farmer trainees under the guidance of project teams, these hubs have increased the institutional capacity of project partners to disseminate improved technologies to farmers as well as conducting vegetable research and development activities (Annex 11). During the impact assessment survey, 68% of those who attended training (direct beneficiaries) were found to be applying various skills taught as compared to only 4% of those who were practicing before training (control group).

b) In 2016, VINESA developed a series of videos to help farmers improve their vegetable production skills. This series called "Growing with VINESA", found at https://avrdc.org/vinesa-videos/, has also been posted at the Access Agriculture Website, an international NGO which showcases agricultural training videos in local languages (http://www.accessagriculture.org/node/1340/en). The videos are also found in AgTube (https://www.agtube.org/en/categories/vegetables?page=1) and World Vegetable Center's YouTube channel (https://www.youtube.com/user/WorldVegetableCenter) where they have been downloaded many times by agricultural research and development staff, service providers, extension agents, communication professionals and farmers.

c) During the baseline survey, it was found that small-scale vegetable farmers around VINESA's BPHs in the four countries experience postharvest losses of up to 50%. After training at the hubs, these farmers have now reduced these losses by undertaking pre-cooling, sorting and grading and standardizing their produce to prolong shelf-life while adding value. Selected technologies such as solar driers, zero energy cooling chambers (ZECC) and grading sheds have been set up at community levels to help graduates in training other farmers and for their own use (Annex 6). Farmers have started using these technologies to collectively bulk their produce before subsequently taking them to market few days thereafter.

d) Collective action helps farmers to form producer groups, get better access to high value markets and obtain higher prices for their vegetables. A total of 481 (260 M/221 F) young male and female farmers have been trained at VINESA BPHs since June 2013. After graduation, farmers are encouraged to form their own groups where they can produce and sell their vegetables together (Annex 8). This way group membership for trained farmers (direct beneficiaries) was 78% after training compared to 61% for those who did not attend training (control group).

e) To help farmers identify profitable markets for their vegetables, VINESA has developed a new "Seven Step to Connecting Farmers to New Markets; A Practical Guide" (https://avrdc.org/wpfb-file/7-steps-practical-guide_fact-sheet-rev2-pdf/). This is a low-cost method for identifying specific market opportunities and then linking farmers to those markets for which they are best suited depending on their strength and weaknesses. The guide has found extensive use by private and public value chain players in Malawi, Mozambique and Tanzania to help farmers develop action plans to supply vegetables to selected markets. Its application is helping to converted farmers from their normal culture of "selling what they have grown" to "growing what they can sell" and thus becoming employers for themselves and that of their communities (https://avrdc.org/barakas-story-contract-farming/)

f) One way of helping women and youth to benefit from their farming activities is to assist them to grow vegetables that meets markets needs on a continuous basis. To do this, VINESA project developed a manual called "Value Chain Thinking – A Trainers' Manual" for use by trainers to help farmers identify and respond to vegetable preferences from high value markets. This manual was revised iteratively during its practical use by VINESA partners to incorporate more local examples, integrate more gender-related activities, and translate the manual into local languages. The manual was published by World Vegetable Center in July 2017 (https://avrdc.org/download/publications/from_the_field/agribusiness-value-chains/Value-Chain-training-manual_final_web.pdf).

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Economic impacts from VINESA project include the following.

a) VINESA is working with other value chain players to connect project graduates to new market opportunities. Between April and June 2016, VINESA trainees in Tanzania realized USD 18,500 from selling 30 tons of French beans, broccoli, lettuce, cauliflower and snowpeas through MVIKIHO [7], an association of horticultural farmers' groups. Across the four VINESA countries, an increased incomes from market-oriented vegetable faming is helping families to pay school fees for their children, build more permanent houses and buy item such as TVs and bicycles, thus improving livelihoods of their households and communities (Annex 12).

b) Smallholder vegetable farmers suffer huge losses after harvest due to limited capacity to increase shelf-life. In Ethiopia, VINESA project partners have established a collection center at Wolisso where a group of 20 farmers have formed a micro-franchise enterprise called "Vegetable and Fruits Production Marketing Enterprises Cooperative Ltd", which will aggregate vegetables from farmers, and grade and pack them before shipment to distant urban markets. This facility will also buy and sell farm inputs to farmers at a discount, helping them to reduce their costs of production.

c) The above-mentioned initiative at Wolisso Town, Ethiopia has also received USD 80,000 funding in one year from the Canada Family Foundation to support the cooperative to undertake other community activities with commercial benefits to its members. This cooperative will also serve communities seven other districts, the Local Government has allocated several Farmer Training Centers (FTCs) for use in vegetable research and development activities. Prior to VINESA, most of these FTCs were used mainly for cereal crops research.

d) Internal group savings and lending are some of the key livelihood skills being imparted on VINESA farmers. About five groups with a total of 120 returning graduates from Tanzania have benefitted from USD 100,000 CRS-funded project which started in July 2017. Collaborating with Equity Bank, this 18 month project will mentor six youth groups on how to develop their budgeting, saving and borrowing skills, which in turn will help them strengthen their group relations and increase productivity and profitability of their farming activities (Annex 9).

[7] *MVIKIHO = Muungano wa Vikundi vya Kilimo cha Horticulture (in Swahili).*

e) Quality seedling production poses a huge economic opportunity for farmers in Maomba District, Mozambique. Since 2014, VINESA has trained over 100 young farmers in this country on how to produce healthy seedlings (Annex 13). As these farmers become proficient producers, they produce cell-grown seedlings at a lower cost than those currently imported from South Africa. The BPH approach, which connects farmers with research and innovation, is being used as a fundamental framework to develop the seedling business in Mozambique.

8.3.2 Social impacts

The following are some of the changes in community practices, culture and gender roles.

a) Among project stakeholders and partners, there is a better understanding of how gender relations impact behaviour and practices of farmers at the BPHs. This awareness has guided project teams in the design and delivery of training activities in the hubs in days and times when girls and women are available, to ensure that they benefit from training to the same extent as men (Annex 14).

b) The notion that leafy vegetables are a diet for the poor while vegetables are meant for women and children is still prevalent in some African cultures (Annex 7). To counteract the negative effects of these beliefs, VINESA has mounted “eat-more-vegetables’ campaigns targeting school children and women who are custodians of household health and nutrition (Annex 10).

c) In Ethiopia, majority of agricultural practices are carried out by male farmers. Women are mainly responsible for household activities including food preparation, housekeeping and child care. During recruitment of the first lot of farmer trainees at Wolisso BPH, no woman came for training. After educating local community on the need for sharing both productive and reproductive roles among household members, there were nine women out of 20 trainees (45%) in the last training.

8.3.3 Environmental impacts

The following environmental impacts are taking place.

a) After graduating from the four BPHs, 481 (260 M/221 F), young farmers are using IPM practices such as planting resistant crop varieties, proper crop nutrition, good crop rotation, and timely planting and weeding, to reduce the use of pesticides. These practices are minimizing contamination of soil and water resources.

b) Low rainfall in some of the years in all VINESA project countries (Ethiopia, Malawi, Mozambique and Tanzania) has resulted in low crop yields, income and poor livelihoods. Use of low-cost drip irrigation systems is helping farmers to increase their water use efficiency and reduce soil erosion by delivering the right amounts of water and soluble fertilizers directly to the crop’s roots zone. VINESA hubs are thus becoming centres of resource-conserving innovations for promoting economic use of water especially in moisture deficient seasons and ecological zones.

8.4 Communication and dissemination activities

At its inception, VINESA developed a project’s Communication and Dissemination Framework. The framework has been using multiple pathways to disseminate information to different external stakeholders; apply participatory methods for knowledge sharing and learning among different project partners; and test the effectiveness of different information dissemination pathways and tools. External stakeholders targeted in the project included: government agencies, extension providers, media, senior managers, local NGOs, private sector actors, smallholder farmers, and consumer groups and associations.

VINESA's dissemination and communication activities included the following.

a) Training curriculum, manuals and theses:

   i. VINESA has developed a new "7 Step Guide to Connecting Farmers to New Vegetable Markets: A Practical Guide" which has been applied in case studies in Malawi, Mozambique and Tanzania (https://avrdc.org/wpfb-file/7-steps-practical-guide_fact-sheet-rev2-pdf/).

   ii. One Value Chain Training manual called "Value Chain Thinking – A Trainers' Manual" for use by trainers to help farmers identify and respond to vegetable preferences from high value markets has been designed and revised to incorporate local examples and integrate more gender-related activities (https://avrdc.org/download/publications/from_the_field/agribusiness-value-chains/Value-Chain-training-manual_final_web.pdf).

   iii. MSc theses:
      a. "Analysis of Factors Influencing Producers and Consumers' Intake of Nutrient-dense Vegetables: the Case Study of Arusha Region, Tanzania" thesis was passed by Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya, July 2016.
      b. "Analysis of High Value Market Opportunities for Smallholder Vegetable Farmers in Arusha Region, Tanzania" thesis was passed by Sokoine University of Agriculture (SUA), Tanzania, October 2017.

b) Field days - In 2013/17 period, a total of 20 farmer field days were held in Ethiopia, Malawi Mozambique and Tanzania. Attended by 2,404 (1,150M/1,254F), these fora served as platforms to share information on best practices and technologies among input suppliers, smallholder farmers, agricultural researchers and extension services providers.
c) Promotional and training videos – see Annex 1.
d) Conferences, workshops – see Annex 2.
e) Newsletter articles – see Annex 3
f) No of youths trained – see Annex 4

9 Conclusions and recommendations

9.1 Conclusions

There were considerable challenges of implementing and managing VINESA project as it spanned four countries (Ethiopia, Malawi, Mozambique, Tanzania) with diverse cultures, languages and at different stages of development. However, to improve nutrition, income and livelihood impacts for smallholder farmers (youth, men, and women), the following conclusions suffice from VINESA's research, training and capacity building activities:

a) A household's level of intake of nutritious, healthy and safe vegetables is based on the nutritional knowledge of its members, especially the head. Nutritional knowledge in turn is influenced by consumer's number of years of schooling, age, level of income as well as the interaction between their education and income levels, and their age and income levels. Thus the socioeconomic characteristics of consumers have a significant effect on their nutrition knowledge and therefore their frequency of intake of nutritious vegetables such as traditional African vegetables (TAVs). This is because consumers' behaviour is a result of the interaction between their personal attributes and the knowledge that they possess.

b) There are various high value markets in urban centers that smallholder vegetable farmers can pursue as sustainable opportunities for profitable self-employment. A step-by-step analysis of these markets, involving farmers in discussions with vegetable buyers, can help smallholder farmers to supplying vegetables to the markets in accordance to farmers' strengths and limitations. However, farmers must work in groups if they are to meet the demand of these lucrative markets for high quality vegetables, timely delivery and consistency in supply.

c) Demand for nutritious and safer vegetables has increased especially among the high education and income segment of urban population. However, an analysis of fresh vegetables sold in markets outlets in major cities in Eastern and Southern Africa contain different types and levels of microbial contamination. A study done in Tanzania provided preliminary findings that can provide a basis for further assessment of food safety issues in fresh vegetable value chains including types and levels of pesticide residues found in fresh vegetables. There is a need for Good Agricultural Practices (GAP) and Hazard Analysis of Critical Control Points (HACCP) in all stages of production, processing, distribution, and sale of vegetables to reduce microbial contamination of fresh produce sold in urban markets in urban centers.

d) Gender integration in agricultural production, especially vegetable farming, cannot be underestimated, because traditionally the small-scale production of vegetables has been the domain of women. Integration of gender in VINESA project was influenced by a number of factors, including gender roles and division of labor that are determined by perceptions of femininity and masculinity in the types of vegetables to be produced and marketed by men and women; lack of a gender objective in the initial project design; discriminative land systems that give preference to married males of the household while excluding daughters at the same time; lack of gender analytical skills by project staff; biases in perceptions of female traders by communities; and little nutritional education and food preparation skills by BPH communities.

e) Despite challenges in (d) above, several achievements have been made, especially in gender sensitization of the project teams, who, after realising the need to involve women, increased the number of women trainees in the subsequent lots of training in all countries. Men and women have learned to share activities, a practice which is gradually being adopted by households and the community. For example, in Ethiopia, there was only one woman in the first lot of trainees; currently, there were 10 women in the third lot of trainees.

f) VINESA's project impact on income and nutrition is very promising. From impact assessment study done in March – July 2017, about 54% of farmers in Ethiopia, 70% farmers in Malawi and 65% farmers in Tanzania expressed high expectations that their new skills on vegetable production and marketing will help to improve nutrition and income for their households and communities in 5 years to come. There is also a significant increase in the level of gender awareness among project staff, farmers and communities as a result of project interventions. This experience will not be limited to VINESA project countries only, but will cascade to other countries in the region.

9.2 Recommendations

The following recommendations could help to promote equitable economic and social development in smallholder vegetable-based farming and food systems in Eastern and Southern Africa:

a) Many consumers, especially from urban settings are now associating consumption of traditional African vegetables (TAVs) with good health – thus they have dropped the notion that traditional vegetables (such as African nightshade, Ethiopian mustard and African eggplant) are inferior to global vegetables (such as cabbages, cucumber and lettuce). However there is a need to improve processing and cooking of TAVs so as to improve their taste and maintain their nutrient content. More promotional campaigns such as radio adverts, posters, road shows and cooking demonstrations are also required to increase consumption of TAVs.

b) Understanding the needs of markets, other customers and end consumers is the first step in making vegetable farming a profitable enterprise for the youth and women. The "7 Steps Guide to Connecting Farmers to New Vegetable Markets" developed by VINESA should be used by stakeholders extensively to convert smallholders from common subsistence farmers to preferred suppliers who can provide vegetables that consistently meet market needs for quality, volume and delivery- this practice could lead to win-win situations for farmers, traders and consumers of fresh vegetables in peri-urban and urban settings.

c) To reduce levels of microbial contamination of fresh vegetables sold in urban markets, food safety education should be provided to vegetable handlers about the proper storage, handling and sanitation of vegetables. Temperature control measures such as the use of cool rooms for storage, refrigeration during transport, and cooling during the final display at the market are important for reducing contamination. Appropriate food safety policies should be enacted and implemented at all stages of the vegetable value chain while market infrastructures should be improved to provide healthy, contaminant-free fresh produce to consumers.

d) Gender related experiences generated by VINESA farmers, communities and other stakeholders in Ethiopia, Malawi, Mozambique and Tanzania should be adopted for improvement and sustainability of the project. There is a need for a policy on gender integration at project team, farmer and community levels in future projects to ensure

more and active participation of men and women in the project cycle, as well as to ensure women benefit from their participation.

e) To promote vegetable consumption at household level, initiatives from VINESA project that increase households' knowledge on the nutritional value of different vegetables and their preparation methods should be scaled out. Future projects should have a gender affirmative policy that stipulates more than 30% of women to participate in project and community structures. Training manuals should include topics on gender analysis skills to help staff develop a perspective on how gender dimensions can influence project's impact on men, women, boys and girls.

f) To increase the adoption of best practices and technologies among smallholder vegetable farmers, and increase project legacy, there is need in future projects to do the following:
    i) VINESA project was implemented across four countries (Ethiopia, Malawi, Mozambique, Tanzania) with diverse cultures, languages and at different stages of development. However, to improve outputs, outcomes and impacts, such projects should be implemented in 1-2 countries with similar social, cultural and economic backgrounds
    ii) include funds within projects to support farmers afford simple technologies (seeds, irrigation, shade nets) that could help them increase productivity of their farming enterprises
    iii) include funds to support short and long-term training of project staff to increase their R&D capacity as well as boost morale within project teams which was not the case in VINESA – despite several attempts, no applicant was successful for John Allwright Fellowships
    iv) ensure selection of project sites conforms with the project's objectives – for example in VINESA only in Tanzania that project was located in a truly peri-urban setting
    v) conduct impact assessment six months after all training activities had ceased in a project to get true reflection of utilization of project outputs and outcomes by project beneficiaries
    vi) appoint a project's communication and dissemination expert who should work with project teams to develop and implement an effective project communication strategy that is appropriate to all target stakeholders
    vii) incorporate specific designs that are gender sensitive from project design stage, through its implementation and evaluation phases
    viii) promote flexible adaptive management in future projects to permit re-allocation of funds between line items as rigid and complicated system discourages changes, flexibility and re-prioritization of project activities
    ix) more effort will be required in selecting partners and/or modifying activities if suitable partners were not available – in VINESA for example, CIP in Mozambique contributed less than anticipated, whilst AHR was underutilized because of their limited funding allocations
    x) convert BPHs into peri-urban Vegetable Business Hubs to equip youth and women with group, business and crop management skills while serving as incubators for small businesses to supply urban markets with safe, nutritious and affordable vegetables. This will complement what is being done through the CRS-funded project in Arumeru district, Tanzania to pilot the successive outcomes from VINESA project by using a triple-pronged model to provide education on good agricultural practices (GAP) to farmers, promote collective marketing to build strong business relationships while strengthen inter and intra-group relationships among the youth groups through "Savings and Internal Lending Communities" (SILC).

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10.2 List of publications produced by project

Table 1: List of VINESA articles at various stages of publications

S/No.	Topic/Subject Matter	Type	Lead Author	Co-Authors	Stage	Timeframe
1.	Connecting farmers to high value markets: A case study of smallholder vegetable growers in Ntcheu District, Malawi	Conference paper – ISHS 2016[8]	John Macharia	Ben Bent, Grace Kamba, Joseph Dzanja, Sera Ngondwe, Thomson Chilanga	Presented, submitted and revised	27 Feb 2017
2.	Assessment of factors influencing farmers' nutrition knowledge and intake of traditional African vegetables in Tanzania	Journal paper (AJFAND)[9]	Kavoi Muendo	Johnson Kimambo, John Macharia, Ngoni Nenguwo	Submitted and revised	29 Aug 2017
3.	Overcoming barriers to improved consumption of TAVs[10] in Tanzania	Journal paper (JAGST)[11]	Kavoi Muendo	Johnson Kimambo, John Macharia, Ngoni Nenguwo	Submitted	13 March 2017
4.	Determinants of consumers' nutrition knowledge and intake of traditional African vegetables in Tanzania	Journal paper (AJFS[12])	Kavoi Muendo	Kavoi Muendo, Johnson Kimambo, John Macharia, Ngoni Nenguwo	Submitted and revised	31 Jan 2017
5.	Microbial contamination of vegetables sold in urban markets in Tanzania	Journal paper (IJPTI)[13]	Joyce Kinabo	John Macharia, Joan Musuya, Helen Mbije, Ngoni Nenguwo	Re-submitted	8 April 2017
6.	Value chain thinking: A Training Manual	TOT manual	Ben Dent	John Macharia	Published by WORLDVEG	30 June 2017
7.	7 step of connecting farmers to new markets: A practical guide	User's guide	Ben Dent	John Macharia	Published by WORLDVEG	12 June 2017
	Pesticide use in vegetable production by smallholder farmers: The case study of BPHs in Eastern and Southern Africa	MSc Thesis[14]	Philipo Joseph	Leah Palm-Forester and Justus Ochieng	Literature review stage	30 September 2018
9.	Analysis of factors influencing intake of Traditional African Vegetables: The case study of Arusha Region, Tanzania	MSc thesis	John Kimambo	Jomo Kenyatta University of Agriculture and Technology (JKUAT), Nairobi, Kenya	Thesis submitted, examined and passed	31 July 2016
10.	Analysis of high value market opportunities for smallholder vegetable growers in Tanzania	MSc thesis	Glory Sumari	Sokoine University of Agriculture (SUA), Morogoro, Tanzania	Thesis submitted, examined and passed	30 Oct 2017
12.	Impact study paper on selected indicators from ongoing endline survey in Ethiopia, Malawi and	Journal paper	Justus Ochieng	Pepijn Schreinemachers, John Macharia	In draft stage	30 Nov 2017

[8] *ISHS = International Society of Horticultural Science*
[9] *AJFAND = African Journal of Food, Agriculture, Nutrition and Development*
[10] *TAVs = Traditional African Vegetables*
[11] *JAGST = Journal of Agriculture, Science and Technology*
[12] *AJFS = African Journal of Food Science*
[13] *IJPTI = International Journal of Postharvest Technology and Innovation*
[14] *University of Delaware, USA*

	Tanzania					
14.	Gender Integration in Agricultural R&D Projects: A case study of vegetable BPHs in Ethiopia, Malawi, Mozambique and Tanzania"	Case study paper	Florence Ghamunga	John Macharia	Submitted to Agri-gender[15]	27 Sept 2017
15.	Analysis of food, health and environment risks from microbial and pesticide residues in fresh vegetables	PhD thesis	Agatha Aloyce	Nelson Madela University of Science and Technology	Study in progress	31 Dec 2020
16.	Protocols for fruit, leaf and bulb type vegetables cultivar testing	User's guide	Fekadu Dinssa	Omary Bwambo, John Macharia, Agatha Aloyce, Oshingi Shilla	Published by WORLDVEG	30 June 2016
17.	Translate, print and distribute training and extension materials for use by TOTs and farmers	User guides, fact sheets, videos, manuals	Hassan Mndiga	John Macharia, Silivester Samali	Translated and distributed	30 April 2017
18.	Increasing smallholder farmers' participation in high value markets	Journal paper	Gloria Sumari	John Macharia Fulgence Mishili	Submitted to JAFS[16]	14 Sept 2017
19	Growing with VINESA is a series of 10 training videos to train farmers on how to: i) produce healthy vegetable seedlings ii) produce quality seeds iii) transplant vegetables iv) make good compost v) get crop nutrition right vi) control white fly in tomatoes vii) cook tasty and nutritious vegetables viii) diversify household diets ix) connect farmers to new markets x) contract farming	Training and promotional videos	John Macharia	Agatha Aloyce, Silivester Samali, Rhiannon Stephen	Published by WORLDVEG	31 March 2017
20	Effectiveness of grafting on control of bacterial wilt in tomatoes in the tropics	Journal paper	Fekadu Dinssa	Juma Kitundu, John Macharia	In draft stage	31 Dec 2017
21.	Integrated Pest Management Practices (IPM) for whitefly in tomato, pepper, chili and eggplant in Africa	Fact Sheer	John Macharia	Mike Titley, Agatha Aloyce and Silivester Samali	Published	31 July 2016

[15] *Journal of Gender, Agriculture and Food Security*
[16] *Journal of Agriculture and Food Security*

11 Appendixes

11.1 Appendix 1:

Annex 1: VINESA videos in a series called “Growing with VINESA” for training farmers

S/No.	Topic	Website Address
1.	The VINESA project: diversifying diets	https://avrdc.org/vinesa-project-diversifying-diets/
2.	The VINESA project: increasing market access	https://avrdc.org/vinesa-project-access-markets/
3.	Producing seeds with VINESA: Joshua success story	https://avrdc.org/producing-pepper-seed/
4.	Contract farming: Baraka success story	https://avrdc.org/barakas-story-contract-farming/
5.	Cooking vegetables with VINESA	https://avrdc.org/growing-cooking-vegetables-vinesa/
6.	Producing healthy seedlings	http://avrdc.org/vinesa-videos/
7.	Vegetable transplanting	http://avrdc.org/vinesa-videos/
8.	Making good compost;	http://avrdc.org/vinesa-videos/
9.	Getting crop nutrition right,	http://avrdc.org/vinesa-videos/
10.	Whiteflies management in tomatoes	http://avrdc.org/vinesa-videos/
11.	Producing quality seeds	http://avrdc.org/vinesa-videos/

Annex 2: Workshops and Conferences – 2013/17

S/No.	Name	Dates	Venue
1.	VINESA Project Inception Workshop	1-4 October 2013	Arusha, Tanzania
2.	1st Annual VINESA Project Review and Planning Workshop	4-6 November 2014	Addis Ababa, Ethiopia
3.	2nd Annual VINESA Project Review and Planning Workshop	6-8 October 2015	Lilongwe, Malawi
4.	3rd Annual VINESA Project Review and Planning Workshop	10-14 October 2016	Maputo, Mozambique
5.	VINESA Project Closing Workshop	29 June 2017	Arusha, Tanzania
6.	TAPP[17] and FtF[18] Joint Nutrition Initiatives Workshops	25-27 March 2014	Morogoro, Tanzania
7.	International Symposium on Tropical and Temperate Horticulture (ISTTH[19] 2016)	20-25 November 2016	Cairns, Australia
8.	African Green Revolution Forum (AGRF 2015)	29 September – 2 October 2015	Lusaka, Zambia
9.	African Green Revolution Forum (AGRF 2016)	5-9 September 2016	Nairobi, Kenya
10.	ACIAR's Food Security Meeting	5-9 September 2016	Nairobi, Kenya

[17] TAPP – Tanzania Agricultural Productivity Program
[18] FtF – Feed the Future
[19] ISTTH – International Symposium on Tropical and Temperate Horticulture

Annex 3: VINESA's Newsletter articles June 2013 – December 2017

S/No.	Topic	Publisher	Where found
1.	"Proximity a plus for peri-urban vegetable production",	ACIAR	http://203.64.245.61/web_docs/media/newsletter/2013/009_Aug-15-2103.pdf
2.	"Peri-urban vegetable production promising for young people in Africa", AVRDC Website	World Vegetable Center	www.avrdc.org
3.	New project to launch hubs for horticulture in Africa	World Vegetable Center	www.avrdc.org
4.	Food security: an urban issue	The Guardian	http://www.theguardian.com/global-development-professionals-network/2013/dec/17/africa-peri-urban-food-security
5.	Pull-driven value chains or push-driven supply chains	World Vegetable Center	www.avrdc.org
6.	Value chain training picks up the pace at vegetable hubs	World Vegetable Center	www.avrdc.org
7.	Ethiopia: new link in the value chain	World Vegetable Center	www.avrdc.org
8.	Entrepreneurship and credit to boost farmers' income	World Vegetable Center	www.avrdc.org
9.	VINESA equips smallholder vegetable growers to engage in high value market opportunities	World Vegetable Center	www.avrdc.org
10.	Youth express optimism over vegetable farming training	The Guardian	Tanzanian daily, 1 April 2015, page 4
11.	Maasai community embraces consumption of vegetables	The Guardian	Tanzanian daily, 23 September 2014, page 4.
12.	VINESA marks its first birthday	World Vegetable Center	www.avrdc.org
13.	Lushoto study tour	World Vegetable Center	www.avrdc.org
14.	Addressing contamination of vegetables from farm to table	World Vegetable Center	www.avrdc.org
15.	A Chameleon in the screenhouse	World Vegetable Center	www.avrdc.org
16.	The master chefs of Ngare Nanyuki	World Vegetable Center	www.avrdc.org
17.	The benefits of BPHs	World Vegetable Center	www.avrdc.org
18.	WorldVeg then and now	World Vegetable Center	www.avrdc.org
19.	Vegetable farmers in Africa benefit from Australian expertise	World Vegetable Center	www.avrdc.org
20.	VINESA graduates savour success from sweet peppers	World Vegetable Center	www.avrdc.org

21.	VINESA builds a culture of budgeting, saving and credit	World Vegetable Center	www.avrdc.org
22.	VINESA farmers challenged to exploit their youth as their greatest asset	World Vegetable Center	www.avrdc.org
23.	Lessons learnt from VINESA	World Vegetable Center	www.avrdc.org

Annex 4: Topics and number of farmers trained in VINESA's BPHs in 2016/17 period

Title of course	Resource Person's Institutions	Award	Dates	No of Trainees	Topics
1. Safe and efficient vegetable production	Africare, WVC, DARSM, EIAR, HORTI, iDE, IIAM, VCM, NIFAD	Certificate of attendance	Aug 2016	481 (260M/221F)	• Seedbed preparation • Soil media sterilization • Nursery management • Seedling hardening • Transplanting • Organic/inorganic fertilizers • IPM practices • Irrigation
2. How to produce quality seeds	Africare, WVC, DARSM, EIAR, HORTI iDE, IIAM, AHR	Certificate of attendance	Sep 2016	481 (260M/221F)	• Seed selection • Field sanitation and inspection • Crop spacing and rotation • Crop management • Seed extraction and storage
3. Reducing postharvest losses	Africare, WVC, DARSM EIAR, HORTI iDE, IIAM, AHR	Certificate of attendance	Oct 2016	481 (260M/221F)	• Sorting, grading and packaging • Vegetable drying and storage • Simple vegetable processing – sauces, pastes and pickles
4. Increasing intake of vegetables	Africare, WVC, DARSM, EIAR, HORTI iDE, IIAM, AHR	Certificate of attendance	Nov 2016	481 (260M/221F)	• Food preparation • Vegetable recipes • Vegetable preparation, cooking and service
5. Becoming successful business entrepreneurs	Africare, WVC, DARSM, EIAR, HORTI iDE, IIAM, AHR, Equity	Certificate of attendance	Dec 2016	481 (260M/221F)	• Targeting high value markets • Becoming preferred suppliers • Building lasting relationships

	Bank				
6. Increasing women role in vegetable farming	Africare, WVC, DARSM, EIAR, HORTI, iDE, IIAM, Tumaini University	Certificate of attendance	Jan 2017	481 (260M/221F)	• What is gender • Gender relations • Gender diversities and their effects on: - Access/control of resources - Division of labour - Decision making
7. Forming strong farmer groups	World Vegetable Center, SUA	Certificate of attendance	Feb 2017	481 (260M/221F)	• Group formation • Group dynamics • Budgets, savings and credit • Business/financial management

WVC = World Vegetable Center, DARSM = Department of Agricultural Research Services, Malawi, EIAR = Ethiopian Institute of Agricultural Research, HORTI = Horticultural Research and Training Institute, Tanzania, iDE = International Development Enterprises, Ethiopia, IIAM = Mozambique Agricultural Research Institute, AHR = Applied Horticultural Research, Australia

Annex 5: Increasing uptake of best practices and technologies by farmers

Plate 1: A prolific tomato crop in a net house in Tanzania rehabilitated through collaboration between TAPP, VINESA and farmers. This and other similar structures were used to train farmers on Good Agricultural Practices (GAP) (Picture taken by John Macharia).

Annex 6: Increasing capacity farmers to use technologies leant from BPHs

Plate 2: VINESA graduates set up a cooling chamber for prolonging vegetable storage using local available materials (Picture taken by John Macharia).

Annex 7: Targeting behavioural changes in communities around the BPHs

Plate 3: Part of VINESA graduates from Tanzania sing a song that calls upon men in their communities to start eating vegetables (Picture taken by John Macharia).

Annex 8: Building capacity of farmers in market-oriented vegetable farming

Plate 4: Sweet peppers are fetching premium prices at supermarkets for VINESA farmer groups from Tanzania (Picture taken by John Macharia).

Annex 9: Building a culture of budgeting, saving and credit in VINESA farmers.

Plate 5: Equity Bank Manager from Arusha, Mr. Bella Mushongi helps a VINESA graduate open a bank account after a two-day training on budgeting, saving and micro-credit in Tanzania (Picture taken by John Macharia).

Annex 10: Promoting heathy and diversified diets among school children.

Plate 6: Primary school children in Tanzania learn how to cook tasty vegetables (Picture taken by John Macharia).

Annex 11: Building stakeholder's capacity for best agricultural practices

Plate 7: Mike Titley from AHR Australia, VINESA's Agronomist show participants of annual review workshop in Maputo, Mozambique the correct use of fertilizers for good root development (Picture taken by John Macharia).

Annex 12: Market-oriented farming's potential to combat youth unemployment

Plate 8: Growing high value crops like this greenhouse in Arusha, Tanzania is helping the youth to supply quality vegetables to markets all the year round thus fetching premium prices and stable income (Picture taken by John Macharia).

Annex 13: Cell-grown seedlings present ready business for Mozambican youth

Plate 9: To produce healthy seedlings requires skills and use of sterile rooting medium, correct fertilizers and good watering as shown here by a VINESA graduate from Moamba, Mozambique (Picture taken by John Macharia).

Annex 14: VINESA is increasing participation of and benefits for girls and women

Plate 10: During training at VINESA's BPHs, girls and women, as seen here during a graduation ceremony in Arusha, Tanzania, are given equal chances to acquire skills of producing nutritious, safe and profitable vegetables (Picture taken by John Macharia).