# SOKOINE UNIVERSITY OF AGRICULTURE

TRANSFORMING AGRICULTURE AND NATURAL RESOURCES FOR SUSTAINABLE DEVELOPMENT TO ATTAIN INDUSTRIAL ECONOMY IN TANZANIA

## DIRECTORATE OF POSTGRADUATE STUDIES, RESEARCH, TECHNOLOGY TRANSFER AND CONSULTANCY

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## Proceedings of Scientific Conference on Transforming Agriculture and Natural Resources for Sustainable Development to Attain Industrial Economy in Tanzania

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## PREFACE

We are privileged to publish the Proceedings of SUA Scientific Conference on 'Transforming Agriculture and Natural Resources for Sustainable Development to Attain Industrial Economy in Tanzania'. The conference was organised by Sokoine University of Agriculture (SUA) to commemorate and honour the life and legacy of the late Hon. Edward Moringe Sokoine, former Prime Minister of the United Republic of Tanzania which was held from 10th to 11th April, 2019 at SUA Main Campus grounds. The proceedings is an output of this scientific conference which serves as a platform to share the knowledge, innovations, solutions, and findings generated by researchers based at SUA as well as those from other national and international partner and collaborating institutions outside SUA.

The Proceedings is organised to cover major sub-themes of the conference namely: Agro-processing and Agro-ecology for Food Security and Economic Growth; Sustaining animal health and livestock productivity; Sustainable environment, natural resources management and tourism; Trade, socio-economic transformation for improved agricultural productivity and Livelihood and Education for skills development and entrepreneurship.

We take this opportunity to thank all contributors, from within and outside SUA, who made efforts to prepare high quality articles published in this proceedings. We appreciate support received from Senate Research and Publication Committee members, Editors of SUA-hosted journals i.e. Tanzania Journal of Agricultural Sciences (Prof. C.N. Nyaruhucha), Tanzania Journal of Forestry and Nature Conservation (Late Prof. S. Iddi-RIP); Tanzania Veterinary Journal (Dr. A.B. Matondo), Prof. J.K. Urassa from the College of Social Sciences and Humanities, and coordination team of Dr. D. Ndossi, Dr. N. Amuri and Ms. L. Madalla during preparations of this proceedings. The Management of Sokoine University of Agriculture is thanked for financial and materials support during organisation of the SUA scientific conference. We recognise generous support from different research projects during conference organisation and production of this proceedings.

I hope that you will find the proceedings to be a useful resource in terms of education and enrichment of your knowledge. Enjoy reading the proceedings!

Prof. E.D. Karimuribo

(Chairman- SUA Scientific Conference)

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# Harvesting Vegetables from a Kitchen Garden: An Educative and Sustainable Approach to Improve Dietary Practices and Nutritional Status among Rural Families in Tanzania

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## Abstract

*Undernutrition continues to inflict significant social, health and economic consequences in developing countries, Tanzania inclusive. The aim of the present study was to implement, monitor and assess the impact of bag gardening and household nutrition education on dietary practices and nutritional status in rural villages in Tanzania. Nutrition education covered various gaps observed in a preceded nutrition survey (baseline). Bag gardening practical demonstrations and hand on implementation skills were carried out to the participating 120 households. McNemar and marginal homogeneity tests were conducted to compare the baseline to endline results for each section of the questionnaire. Results indicated that at baseline only 27% of households had a high Dietary Diversity Score as compared to 52% at endline. Daily and weekly consumption rates increased by 10-50% from baseline to endline periods.There were significant differences in knowledge aspects of factors influencing inclusion of vegetables in a meal, knowledge of bag and cultivation of vegetables in a bag garden, receiving nutrition education before, knowledge of foods that increase intake of fibre, knowledge of food groups and iron deficiency anaemia between the baseline and endline time points with $p<0.05$.The intervention increased consumption of green leafy vegetables, dietary diversity and nutrition knowledge of participants in the topics covered including general nutrition, nutrition requirements for specific groups, preparation and preservation of foods, improving nutrition through kitchen gardens and tips for improving health. We recommend progressing this type of intervention further by selecting foods containing high vitamin A amounts to be included in bag gardens.*

**Keywords:** Kitchen garden, bag kitchen garden, green leafy vegetables, consumption patterns, household, nutrition education

## Introduction

Micronutrient deficiencies in human diets continue to impose significant social, health and economic consequences in the world. This may be due to poor nutritional practices, low availability of foods rich in micronutrients, poor agricultural practices leading to micronutrient depleted soils and inadequate knowledge about nutrition and food (Burchi *et al.*, 2011). The consequences of poor nutritional status include reduced work capacity due to growth retardation, impaired cognitive function and immunity, complications in pregnancy leading to poor pregnancy outcome and increased risk of morbidity and mortality mainly in children and women (Caulfield *et al*, 2006). In Tanzania as for other developing countries, micronutrient deficiencies are common. Strategies to combat micronutrient deficiencies at national level mainly involve supplementation and fortification with specific micronutrients such as iron, folic acid and vitamin A. However, attainment of success is limited because the approach

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strongly relies on international aid (Fiedler *et al.*, 2003), lacks communication with all at risk populations as logistics of delivery are usually undependable and conflicting. In addition, supplementation and fortification mostly target only sub groups of the population, usually children under five years of age and women of reproductive age (Gautam *et al.*, 2008). An alternative sustainable approach is a food based one to increase consumption of micronutrient rich foods. This can be done by introducing kitchen gardens of green leafy vegetables and small animals/livestock rearing. Kitchen gardens are a cheap local strategy that is broadly practiced by local communities using limited resources.Such gardens are a part of the agriculture and food production systems in many developing countries and are widely used to complement production of cereals and pulses (Gautam *et al.*, 2006). A kitchen garden approach assures prolonged sustainable supply of micronutrient rich vegetables through production at the door step. Kitchen gardens can help to improve the diets through increased consumption of a variety of vegetables. In rural areas of Bangladesh for example, households with a kitchen garden had children of better nutritional status (Talukder *et al.*, 2010). Even with these positive observations, another study (Thompson & Amoroso, 2010) indicated that the kitchen garden approach alone may not be a total solution for reducing micronutrient deficiencies. Therefore, in order for kitchen gardens to be effective in improving nutritional status, other supporting interventions such as nutrition education to improve knowledge on adequacy of the diet and skills on healthy food preparation methods should accompany it.

This study adopted the approach of a household based nutrition education in the targeted households in order to impose the maximum effect of equal participation of the intervention activities towards improving the nutrition situation and ensuring maximum retention of knowledge and skills at household level. The aim of the present study was therefore to identify the need, develop, implement and assess the impact of kitchen gardens coupled with household nutrition education program on consumption patterns, dietary diversity and nutritional status of rural household members.

## 3.0 Materials and Methods

### Study location

The study was conducted in two different agro-climatic zones in Tanzania namely: sub humid Morogoro region and semi arid Dodoma region. The two regions Morogoro and Dodoma were selected because they represent two different food systems and have sufficiently diverse environmental and socio-economic conditions for investigating causative factors for food and nutrition insecurity thus allowing for the transfer of results to other regions of Tanzania with similar characteristics.A cluster sampling method was used to select four villages in Kilosa and Chamwino districts.In Morogoro region, Kilosa district was selected and Changarawe and Ilakala villages were selected and in Dodoma region, Chamwino district was selected and Ilolo and Idifu villages were selected. The majority of the population in the study villages depends on farming as their main livelihood activity.

**Study population, sampling procedure and design**

The population comprised all household members including women, care givers, men, the youth and children in the sampled households. This study followed a one group pre test-post test design to determine the effects of the intervention by comparing the pre test and post test results. A baseline survey was conducted and then follow-up with the same households and participants at endlineafter twelve months. Baseline and end-line data collection was done through a face to face administered questionnaire and anthropometric measurements. A sub sample of 30 households with children below five years of age was purposively selected from the main sample of each village to be included in the study making a total of 120 households. Verbal and written consent was obtained from participants and ethical clearance was obtained from the Tanzania National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2226).

**Baseline and end line surveys**

A face to face interviewer administered questionnaire was used to collect demographic and socioeconomic information and to identify knowledge gaps of mothers'/caregivers' in nutrition and kitchen gardening in the selected households. Data on household dietary diversity was collected using a dietary diversity questionnaire developed by Food and Agriculture Organization of the United Nations (FAO) with twelve food groups and was used to assess household dietary diversity scores (HDDS) which is defined as the number of different food groups consumed by households over 24 hours. The results of the baseline survey indicated that nutrition knowledge, practices and attitudes particularly those related to general nutrition, nutrition requirements for specific groups, preparation and preservation of foods, importance of kitchen gardens in improving nutrition status and basics for improving health through nutrition were poor and required the most improvement (Mbwana*et al.*, 2016).

**Nutrition training program**

The household nutrition training materials were developed based on the knowledge gaps and needs identified from the nutrition baseline survey conducted in the study areas. One training module with five topics was developed. The topics included: General nutrition and consumption of micronutrient rich foods within households, nutrition requirements for specific groups, preparation and preservation of food, improving nutrition through kitchen gardens and finally tips for improving health through nutrition.

Content validity of the materials developed was done by a panel of five experienced nutritionists who are researchers and academicians. The experts validated the accuracy of the information presented and the cultural sensitivity of the materials. The materials were also presented to project members during a meeting. The meeting participants were requested for general comments and suggestions which were later incorporated to improve the materials. Training was done once every month for three months consecutively. Two training sessions per day were done at the central demonstration household with a total of 30 men, women and the youth from the study households. The vegetable cooking demonstrations included actual cooking and eating. One training

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session lasted for about 3 hours. A total of 15 hours were used to cover the whole module of training.

**Kitchen gardening**

One central household in each village was identified as a demonstration site for the kitchen gardens. Bag gardens were selected to be implemented in this study because they are space sparing, efficient in terms of using water, suitable for areas with little or no healthy soils (as the soil in the bag is contained) and they require only low physical labour. Bag gardens, also known as "vertical farms or gardens", are tall bags filled with a mixture of soil, sand and manure from which plant life grows. The bag is filled with a centre column of gravel which allows for drainage and water distribution throughout the bag. Slots made on the vertical sides of the bags enable plants to grow but vegetables can also be planted on top of the bag. A model bag kitchen garden was established on one site in each village, and then all participating farmers were required to implement the same at their households. Types of vegetables planted included Chinese cabbage, collard greens, spinach, sweet potato leaves and amaranth as suggested by the farmers themselves.

**Monitoring of interventions**

A number of indicators were developed which were used to monitor the performance of the intervention on a bi-monthly basis. A simple researcher administered tool with the indicators was administered to all participating households after every two months.

**Nutrition status assessment**

The height (in cm) and weight (in kg) of children and their caregivers in the sampled households were measured. Weight was measured to the nearest 0.1 kg using a SECA electronic bathroom scale (A SECA, Vogel and Haike, Hamburg, Germany). Height was measured using a stadiometer (Shorr Productions, Perspective Enterprises, and Portage, Missouri, USA).

**Data analysis**

All analyses were performed using IBM SPSS Statistics for windows, Version 21 (IBM Corp., Armonk, New York, USA). Data were presented using frequencies, percentages frequencies, means and standard deviations. Food consumption patterns and practices were compared before and after intervention. Emergency Nutrition Assessment (ENA) was used to classify the study children into categories of nutritional status into z-scores which were used to define stunting, underweight and wasting in children.For women, Body Mass Index (BMI) was used to define nutritional status. Paired t-test was used to compare the nutritional status of children and their caregivers at baseline and endline periods. The dichotomous categorical data for assessing differences in responses to nutritional knowledge in the baseline and endline time points were analysed using McNemar test. The marginal homogeneity test was used for categorical variables with more than two responses to assess the marginal frequencies. Significance was considered when $p< 0.05$.

## 4.0 Results

A total number of 120 households were involved at baseline and 100 households at endline. Household size ranged between 6-8 persons at baseline (48%) and endline (44%). The proportion of female headed households was 15% at baseline and 23% at endline. The respondents who had not attained any formal education were 33%. The demographic information of the households and respondents are presented in Table 1. Majority of the children were in the age group of 42-53 months with mean weight of 14 kilograms and height of 95.9 centimetres at baseline. At the endline the majority of children were in the age group of 30-41 months with average weight of 11.8 kilograms and the height of 86.5 centimetres.

**Table 11: Physical and demographic characteristics of households**

| Characteristics | Baseline (n=120) | | End-line (n=100) | |
|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation |
| Age of respondents (years) | 44.33 | 17.086 | 41.95 | 12.156 |
| Weight of caregivers (kg) | 54.76 | 11.788 | 54.13 | 11.551 |
| Height of caregivers (cm) | 153.29 | 6.872 | 153.56 | 12.628 |
| | n | % | n | % |
| **District of origin** | | | | |
| Chamwino households | 60 | 50 | 53 | 53 |
| Kilosa households | 60 | 50 | 47 | 47 |
| **Sex of household head** | | | | |
| Male | 102 | 85 | 77 | 77 |
| Female | 18 | 15 | 23 | 23 |
| **Marital status of household head** | | | | |
| Married-monogamous | 73 | 60.8 | 58 | 58.0 |
| Married-polygamous | 9 | 7.5 | 5 | 5.0 |
| Widowed | 18 | 15.0 | 11 | 11.0 |
| Divorced | 5 | 4.2 | 10 | 10.0 |
| Single | 4 | 3.3 | 3 | 3.0 |
| Cohabitation | 11 | 9.2 | 13 | 13.0 |
| **Level of literacy of caregiver/mother** | | | | |
| Not able to read or write | 53 | 44.2 | 35 | 35.0 |
| Can read and write to some extent | 25 | 20.8 | 11 | 11.0 |
| Can read and write | 42 | 35 | 54 | 54.0 |
| **Occupation of respondent** | | | | |
| Farmer | 113 | 94 | 98 | 98.0 |
| Employed formal sector | 2 | 1.7 | 1 | 1.0 |
| Self-employed/other | 1 | 1.0 | 1 | 1.0 |
| Other | 4 | 3.3 | 0 | 0.0 |
| **Education level of respondent** | | | | |
| No education | 40 | 33.0 | 36 | 36.0 |
| Primary education | 74 | 62.0 | 58 | 58.0 |
| Secondary education | 4 | 3.2 | 3 | 3.0 |

| | | | | |
|---|---|---|---|---|
| Adult Education | 2 | 1.8 | 3 | 3.0 |

**Kitchen garden knowledge and practices**

Within three months of first demonstrations, all study households had established one or more gardens; planting various types of green leafy vegetables. The water sources used for growing bag gardens in the study villages were well water, rain water and household waste water. Further results regarding questions asked on kitchen gardening are presented in Table 3.

Nutrition knowledge of respondents

Knowledge on balanced diet increased by 35% during the two periods as more respondents could provide right responses to the questions on balanced diet.Table 2 indicates nutrition knowledge of participants during the baseline and endline surveys.

**Table 2: Nutrition knowledge of respondents at baseline and endline periods**

| Question asked | n | % | n | % | Effect of knowledge | P-valuea |
|---|---|---|---|---|---|---|
| | Baseline | | Endline | | | |
| Have you received any training about nutrition before | | | | | ↑ | 0.005MN* |
| Yes | 28 | 23.3 | 82 | 82.0 | | |
| No | 92 | 76.7 | 18 | 18.0 | | |
| How often should children 2-5 years be fed | | | | | ↑ | |
| Once | 2 | 2.1 | 5 | 5.0 | | 0.065MH |
| Twice | 67 | 55.8 | 15 | 15.0 | | |
| Thrice | 38 | 31.2 | 68 | 68.0 | | |
| More than three times | 11 | 8.8 | 11 | 11.0 | | |
| Do not know | 2 | 2.1 | 1 | 1.0 | | |
| **How many servings of fruits and vegetables a day are advised for people to eat** | | | | | ↔ | 0.081MH |
| One | 35 | 28.8 | 14 | 14.0 | | |
| Two | 42 | 34.8 | 46 | 46.0 | | |
| Three | 27 | 22.5 | 32 | 32.0 | | |
| Four | 1 | 1.1 | 2 | 2.0 | | |
| Five | 1 | 1.1 | 1 | 1.0 | | |
| Do not know | 14 | 11.7 | 5 | 5.0 | | |
| **What is a balanced diet** | | | | | ↑ | 0.349MH |
| a diet rich in protein | 6 | 5.2 | 5 | 5.0 | | |
| a diet poor in fat | 2 | 1.8 | 2 | 2.0 | | |
| a diet containing all nutrients in proper quantities | 17 | 13.8 | 49 | 49.0 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Do not know | 95 | 79.2 | 44 | 44.0 | | |
| **Do you know foods that increase intake of fibre** | | | | | ↑ | 0.083 |
| Yes-with correct example | 7 | 5.4 | 34 | 34.0 | | |
| Yes -with wrong or no example | 8 | 7 | 18 | 18.0 | | |
| No | 105 | 87.6 | 48 | 48.0 | | |
| **Do you know any kinds of food groups** | | | | | ↑ | 0.008[MN]* |
| Yes with correct examples | 18 | 14.8 | 95 | 95.0 | | |
| No | 102 | 85.2 | 5 | 5.0 | | |
| **Have you ever heard about iron deficiency anaemia** | | | | | | |
| Yes | 94 | 78.3 | 90 | 90.0 | ↑ | 0.023[MN]* |
| No | 26 | 21.7 | 10 | 10.0 | | |
| **Can you list examples of foods rich in iron** | | | | | | |
| Organ meat | 3 | 2.3 | 3 | 3.0 | ↑ | 0.078[MH] |
| Flesh meat | 3 | 2.3 | 10 | 10.0 | | |
| Dark green leafy vegetables | 50 | 41.3 | 55 | 55.0 | | |
| Beans | 3 | 2.3 | 20 | 20.0 | | |
| Insects eg grasshoppers | 1 | 1.4 | 2 | 2.0 | | |
| Fish and sea foods | 1 | 1.4 | 2 | 2.0 | | |
| Does not know | 59 | 49 | 8 | 8.0 | | |
| **May I see the salt used to cook the main meal eaten by HH members** | | | | | | |
| Iodized | 55 | 46.2 | 50 | 50.0 | ↑ | 0.069[MH] |
| Not iodized | 61 | 51.1 | 39 | 39.0 | | |
| No salt at home | 4 | 2.7 | 11 | 11.0 | | |

[MN]McNemar test, [MH]Marginal homogeneity test* Significant at $p<0.05$

**Household dietary diversity and consumprion of green leafy vegetables.**

At baseline only 27% of households had a high HDDS as compared to 52% at endline.Figure 1.About 68% of households reported to have consumed green leafy vegetables in the previous 24 hours prior to the survey day. Daily consumption of different green leafy vegetables during the baseline and endline periods was observed to increase.

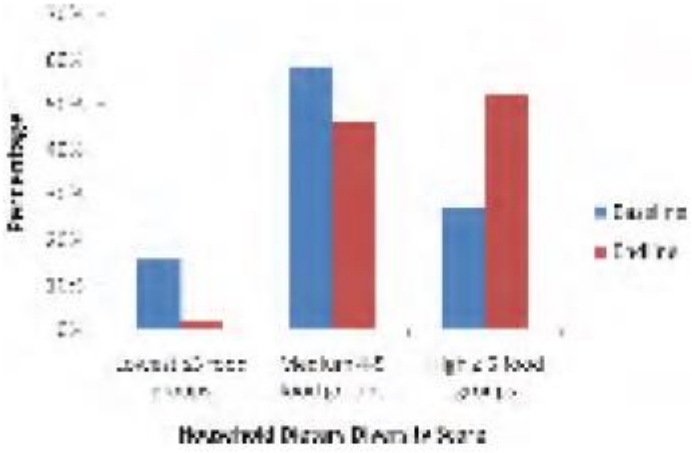

**Figure 1: Dietary diversity classification**

**Nutritional status of children and mothers/ caregivers**

The overall prevalence of stunting based on HAZ/LAZ for the total sample was 41% and 40.2% at baseline and endline respectively. The prevalence of underweight and wasting based on HAZ, WAZ and WHZ are indicated on Figure 2.

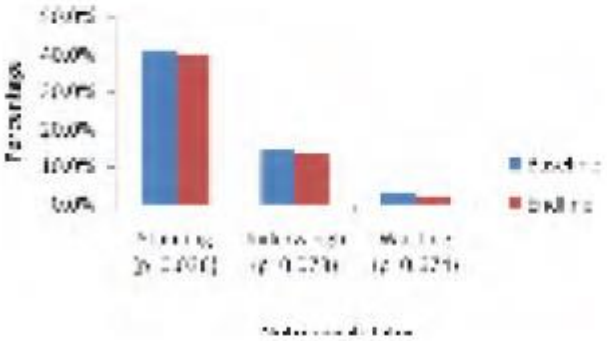

**Figure 2: Child nutritional status**

**5.0 Discussion**

The semi longitudinal nature of this study allowed researchers to measure change over time, thus permitted to prove causality between taking part in the nutrition and kitchen gardening education program and the improved nutrition knowledge, consumption patterns and dietary practices of the participating households. In the current study,

there was a substantial increase in the performance indicators used to monitor the intervention such as improved nutrition knowledge, increased vegetable production, increased frequency of green leafy vegetable consumption and dietary diversity. On the part of nutritional knowledge, significant increases between the baseline and endline responses were seen on the aspects related to have received any nutrition training before, how often should children below five years be fed per day, knowledge about foods that increase intake of fibre, knowledge of food groups and the use of iodised salt at household level. Increase in knowledge was also observed on aspects of a balanced diet, iron deficiency anaemia and examples of foods rich in iron.

Reported practices of nutrition were better during the endline period as compared to the baseline period. This may indicate that the information supplied during the trainings was maintained by the participants for the whole period until the endline time and probably they will implement throughout their lives. Significant improvements in knowledge were found in various aspects. Other studies also reported improvements in nutrition knowledge after the implementation of nutrition education and kitchen gardening (Cannoosamy, Pem, Bhagwant, and Jeewon, 2016; Pillai, Kinabo, and Krawinkel, 2016). Comparable results were also reported by Powers, Struempler and Parmer (2005)where people in the nutrition education intervention group revealed significantly better improvement in nutrition knowledge. However, there are conflicting findings where knowledge scores did not increase significantly from the baseline to the endline(Garcia-Lascurain, Kicklighter, Jonnalagadda, Boudolf, and Duchon, 2006), which may be caused by disparities in the coverage of nutrition information, family environment, and food availability and accessibility or using a not applicable way of knowledge transfer (Shariff *et al.*, 2008).

The consumption of introduced vegetables such as amaranth, collard greens, spinach and Chinese cabbage increased at the endline and the proportion of households using these vegetables was higher at the endline than in the baseline survey. Such improved diversity in green vegetable consumption is crucial to guarantee enough intakes of important vitamins and minerals for optimal growth and development (Burchi *et al.*, 2011). In other developing countries, home gardening increased production and consumption of vegetables in the beneficiary households as compared to the controls and also vegetable diversity was reported (Talukder *et al.*, 2010). In addition, the nutritional contribution of animal foods to dietary diversity is unquestionable. The majority of the households in rural areas of developing countries have low HDDS and foods from animal sources are uncommon in the household's diets (Ruel, 2003; Workicho *et al.*, 2016). Therefore animal source foods should be equally consumed because they are a good source of nutrients that are needed for growth and that sustain the immune system (Darapheak, Takano, Kizuki, Nakamura, and Seino, 2013).

The small income obtained from sale of surplus vegetables is also used to buy other food items such as tomatoes, salt, sardines and cooking oil, which in turn increased diversification of the family's nutrition (Acham, Oldewage-Theron, and Egal, 2012; Sanusi, 2011; Talukder *et al.*, 2010). Other studies also documented improvement in dietary diversity, nutritional knowledge and increased consumption of vegetables

(McAleese & Rankin, 2007; Pillai *et al.*, 2016; Schreinemachers *et al.*, 2016). The combined bag gardening and nutrition education in this study also indicated a slight positive effect on aspects of nutritional status such as child stunting, underweight, wasting and BMI of mothers/caregivers. Variable information regarding improvement of nutrition status is reported by various studies. Studies by Schipani *et al.*, 2002 and Sheikholeslam*et al.*, 2004, found a positive and significant impact on stunting and wasting prevalence after a gardening and nutrition education program whereas Malekafzali*et al.*, 2000 and Masvongo*et al.*, 2012 reported a reduction of underweight.

Regarding the performance indicators, the study experienced many optimistic outcomes. The number of bag gardens per household showed a positive outcome. At the beginning of the intervention, majority of households had one to two gardens, but at twelve months after the intervention, the majority had two to three gardens and all households had at least one garden. Similarly, in other areas, water shortage was also reported to be a major constraint for the development of gardens, especially in semi-arid areas (Galhena etal., 2013; Merrey and Langan, 2014). The problem of pests and diseases was solved by providing hands on skills on application and use of organic pesticides. Another study which examined component relations and productivity of the home garden system in India reported diseases and pests to be among the chief constraints (Pandey, Rai, Singh, and Singh, 2007).

**Conclusion and Recommendations**

One of the most positive outcomes of the study was a vast response towards the bag garden intervention. Many households within the intervention villages and also from the neighboring villages wanted to take part at the kitchen garden training. Our results demonstrate that the bag garden and nutrition education approach has the probability to improve dietary diversity, consumption patterns and micronutrient status of communities in rural areas such as Kilosa and Chamwino districts. The kitchen garden/nutrition education approach is a simple and sustainable approach for addressing the problem of micronutrient malnutrition. Even though the results of this study are encouraging the contribution of the program to overall nutrition and food security may be studied in inclusion of: A control study design may be needed to evaluate the impact of a blend program of nutrition education and kitchen garden on combating specific micronutrient deficiencies such as iron and vitamin A deficiencies, implementing this blend of intervention with other interventions such as de-worming and water, sanitation and hygiene and establishment of an improved point for seed and seedling sale in the localities. This can also involve empowering local communities to produce and distribute seedlings.

**Conflict of interest**

The authors declare that they have no conflict of interest.

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