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YOUTHS AS RECIPIENTS AND PROVIDERS OF AGRICULTURE INFORMATION – THE VERTICAL VEGETABLE GARDENING CASE IN BUSIA COUNTY, KENYA

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ABSTRACT

The intent of this study was to assess the feasibility of engaging youths in secondary schools in disseminating agricultural information among smallholder farmers using a five-month vertical vegetable gardening technology case in Busia County, Kenya. The research employed mixed research design targeting smallholder farmers and youths in secondary schools. A sample of 132 smallholder farmers and 132 youths in their first, second, and third years of study were selected to participate in the study at the baseline survey, during the intervention, and at the closure survey. The baseline survey was used to identify gaps, followed by participatory training intervention on the mound bed, primary tower, and second wall, to create awareness about vertical vegetable gardening through young farmers' clubs, and a closure survey to assess the change caused by the intervention and the feasibility of the approach. The study used kales, black nightshade, swiss chard, capsicum and carrots as examples of vegetables suitable for vertical gardens. Data was analyzed using the Wilcoxon sign-rank test at $p<0.05$ level of significance, thematic and descriptive analysis. The results showed that there was a significant change in access and use of vertical gardening information by smallholder farmers. At $P = 0.000$, 22% of the smallholder farmers appreciated the use of vertical vegetable gardening at the closure survey, compared to 1% at the baseline survey. The dissemination of information through secondary school youths allowed for multiple delivery channels, was a good technology result demonstration approach for technology replication, and had sufficient agricultural extension activity learning scope. Significant change in the level of technology acceptance offer practical implications for policy makers to support the role of youths in agricultural extension. Future studies are needed to examine suitable agricultural extension policies and strategies to increase the successful implementation of agricultural extension through secondary schools.

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INTRODUCTION

The number of young people (aged 15–24) in Africa is projected to increase by about 95 million by 2030. The projected population increase demands an increase in agricultural productivity for food and nutrition security (Fan *et al.*, 2020). Youth involvement in agriculture can

help meet the demands as it promises sustainability in agriculture while addressing poverty and inequality (Davis *et al*., 2018).

However, there is still low participation of youths in agriculture due to inadequate motivation, knowledge, and technical experience in farming since they receive less attention and guidance from agricultural extension (Geza *et al*., 2022).

There is a global recognition that for the world to achieve food and nutrition security through agricultural extension, special attention must be given to the youth as they are critical agricultural players. This is supported by the findings of a study carried out by Developing Local Extension Capacity (DLEC) in Rwanda. The findings of the study showed that youths in agricultural extension are good recipients of agricultural information (Babu *et al*., 2021). The study further explained that supporting and strengthening youth inclusion in agricultural extension can improve their economic opportunities and livelihoods while at the same time increasing the effectiveness of agricultural extension and advisory service systems.

The approach of engaging youths in agricultural extension in Kenya has not been fully embraced. The challenges of limited access to land and the availability of few agricultural extension activities that target youths further hinder them from maximizing the opportunities. In Busia County, Kenya, there is limited youth's involvement in gainful agricultural activities, threatening the stability of agricultural development in the county (Republic of Kenya, 2018). To add to this, the preview of the CIDP 2013–2017 showed that there was low adoption of technologies such as urban and peri urban agricultural technologies despite them being sustainable and utilizes limited resources in production (Republic of Kenya, 2018). This presents an opportunity where youths can be directly involved in agricultural activities and provide a meaningful contribution for community development as they are the most energetic group. Youth's involvement in agricultural extension can enhance farmer-to-farmer extension, hence offering opportunities for promoting sustainable production for agricultural development (Hamilton *et al*., 2015). Hence, there is a need for agricultural programme developers, agricultural extension providers, and policymakers in Kenya to consider the role of the youths in agricultural development and associated opportunities (Maulu *et al*., 2021).

Approaches such as Positive Youth Development (PYD) have been used to improve agricultural extension among youths for agricultural development (Dimitrova & Wiium, 2021). At the turn of the 20th century, "tomato clubs" undoubtedly played a role in improving agricultural productivity (Uricchio *et al*., 2013). The 4-H approach made it possible to even reach out to the laggards. The tomato clubs were the most effective way of convincing farmers of the need and value of good agricultural practices while educating the next generation of farmers (Morgan, 2021). As a result, there were improved yields, food and nutrition security, as well as profits from the sales of the processed and canned tomatoes. The procedures that were used in tomato and corn clubs can be adapted to improve agricultural extension today.

However, in Kenya, guided by the objective of "providing a platform where the youths could showcase innovations and technologies," the 4-K clubs failed to have a sustainable and immediate impact on the targeted community for agriculture development. The four Ks stand for "Kuungana, Kufanya, Kusaidia Kenya" in Swahili, loosely translating to "coming together, to act, to help Kenya. As the curriculum evolved, the clubs became dormant in the 1990s (Laban *et al*., 2021). This greatly impacted food production, causing the government to rethink the strategy of reviving the sector, targeting the youths as the next generation driving agriculture. This led to the clubs being re-launched in the year 2021. However, to date, the initiative has not been fully implemented. This points to the need for relevant stakeholders to rethink other strategies that can enhance the implementation of these 4-K clubs. Early in the 21st century, the Young Farmers Club-Kenya (YFCK) was established and mainly focused on improving youths' psychomotor skills. The YFCK, however, lacked a link between youths in schools and farmers for sustainability and wider knowledge dissemination (Simões, 2018).

The approaches used in the 4-H, YFCK, and 4-K clubs had promising impacts on increasing food production for sustainable food security and economic development. However, the approaches used in YFCK/4-K did not fully explore the role of youth's engagement in agricultural extension for agricultural development among the farming communities in Kenya. Maximizing the agricultural extension information dissemination opportunities that exist in such societies can

significantly provide an option for agricultural extension to diversify into new strategies, that can enhance service delivery, bridge the gap of understaffing, limited youth's engagement, and ever diminishing resources. As a result, it is important to examine the role of youths as recipients and providers of agricultural information in agricultural development.

METHODS

Characterization of the Study Area

The study was conducted in Teso South Sub- County, Busia County, located in the western region of Kenya. The county has a total population of 886,856 people, with youths accounting for about 38% (Kenya National Bureau of Statistics, 2019). Agriculture is the major economic activity in the county. Maize, beans, millet cassava cotton, tobacco and sugarcane are the major crops grown in the area. However, the average farm land size is 1.71 acres, hence agriculture is done on a small scale. The rainfall pattern in the area allows for two cropping seasons; however, the majority of the smallholder farmers rely on rain-fed agriculture, hence low and seasonal productivity in every season. The rapidly growing population, average farm size, farm productivity, and climate patterns in the county have significantly affected food production. This has increased food insecurity, malnutrition and poverty (Republic of Kenya, 2018). Agricultural extension in the county that is aimed at bridging the gap of low productivity for rural development is faced with challenges of limited resources and understaffing. Hence it is important to utilize different approaches to agricultural extension that would bridge the gap of limited production, youth engagement and limited advisory services.

Research Design

Both quantitative and qualitative approaches were used to implement the three stages of the study; baseline survey, intervention, and closure survey. The baseline survey was conducted to understand the training needs and suitable intervention. The intervention was carried out to create awareness about three vertical vegetable gardening techniques using a training manual developed following the baseline survey. The closure survey assessed change caused by the intervention and the feasibility of agricultural extension through schools while comparing it to an ideal or tested agricultural extension approach.

A survey was undertaken to understand the overall situation of vertical vegetable gardening and access to agricultural extension information by smallholder farmers from schools and public extension at the baseline and closure surveys. The survey drew responses from smallholder farmers and youths in secondary schools. The qualitative approach involved the use of action research, focus group discussion (FGD), and observation. Action research was used to introduce the intervention after the baseline survey. Observation guides were used to assess the utilization of available spaces for farming activities within the school compound at the baseline survey, the performance of each technology and opportunities for multiple information delivery channels and to find out how much of what had been learned was applied at the closure survey. FGD was used for training needs assessment at the baseline survey.

Baseline Survey

The baseline survey included two main activities; assessment of the training needs and identification of suitable intervention. The study began with the sensitization of targeted respondents in the study. They included smallholder farmers and schools because the study targeted youths in secondary schools. The sensitization meeting between the researcher and targeted respondents was aimed at introducing the new project, explaining the upcoming activities, and clarifying any questions asked by the respondents.

For training needs assessment, two sets of FGD were conducted among smallholder farmers using semi-structured discussion guidelines. The average FGD included six participants, and the FGD was conducted on an average session of two hours. The discussion focused on vegetable production and consumption and access to vegetable production information. A survey was also completed by both smallholder farmers and youths in secondary schools. The survey was conducted to understand the status of vegetable production, the concept of vertical vegetable gardening and the status of agricultural extension through schools and public extension. At the baseline survey, the observation guide was used to assess the utilization of empty spaces for agricultural farming within the school compound. The

baseline survey was conducted by the researcher during the first month of the project.

Intervention

The study intervention included the formation of YFCK as there were no active clubs in the four sampled day secondary schools (St Joseph Chakol, St Mark Ngelechom, St Elizabeth Okateko and St Mark Machakusi) and participatory training on three vertical gardening technologies; mound bed, primary tower, and second wall. Details of the findings of the baseline survey that informed on the suitable intervention are included in the result section of the paper.

Formation of Young Farmers' Club (YFCK)

The YFCK in each school was formed by all youths who showed interest in vertical vegetable gardening. According to Quesada *et al*. (2020), in most cases group dynamics in the formation of YFCK, such as gender, level of learning agriculture in school, and selection of agriculture as a subject of interest in school are considered insignificant in influencing learning and skills acquisition of skills. All the youths who showed interest were allowed to participate in vertical vegetable gardening project in each school. The agriculture subject teachers in the respective schools coordinated the activities of the clubs.

The active participation of agriculture subject teachers was key to the sustainability of YFCK and their activities. The YFCK was used as an entry point for agriculture extension and an avenue for group learning among youths in the three classes in secondary schools that were sampled in the study.

Participatory Vertical Vegetable Gardening Training

The participatory training focused on three vertical vegetable gardening technologies; primary tower, second wall, and mound bed. The training was conducted in two phases. The first phase involved theoretical learning that highlighted key areas of vertical vegetable gardening concepts, benefits of vertical gardening and the steps involved in establishing each technology. The details of the theoretical training are attached in the appendix as a brochure. A printed copy of the brochure was also given to each student for reference as they try the technologies at home and also to share with smallholder farmers or guardians. After theoretical learning, participatory training was then conducted during the establishment, planting, management, and harvesting of produce within the life of the project as seen in Figure 1. The activities that were conducted during participatory learning were conducted between the second and the fourth month of the project. Youths in the YFCK were directly involved in all the activities during this stage. During this stage youths in YFCK established kales production sustainability scheme that involved the use of thousand headed kales variety. The suckers that were produced were later used in growing second season of vegetables in the gunny bags, while excess suckers were shared among the youths, to use them for home trials as they establish their own vertical vegetable gardens.

Figure 1. Students Participating in Establishing Vertical Gardens in School.

Source: Picture taken by the researcher during the intervention.

The study used locally available, sustainable resources during the intervention in schools to encourage improvisation in vertical vegetable gardening at homes. These resources included construction and planting materials that were used in the vertical vegetable gardens. However, the labour as a resource was largely provided by the youths as part of their skills acquisition and learning process as seen in Figure 1.

In each school, five vertical gardens were established. For gunny bag technology (second wall and primary tower) four structures were established. For mound bed one structure was established in each school. The study adopted the east-west sun rays' direction while establishing the four gunny bags vegetable gardening structures. The aim was to assess the performance of each gunny bag technology depending on the direction they were facing. This was to guide the students identify a good site for establishing the vertical gardens at home. There gunny bags were separated using a wall made of timber off cuts. There were two structures (second wall and primary tower) on each side of timber off cuts wall which gave each structure an equal advantage of harnessing either morning or afternoon sun rays as seen in Figure 1. Black nightshade, kale, swiss chard, carrots, and capsicum vegetables were used in the study as examples of vegetables that can be grown on vertical gardens. In order to reduce the cost of production, onions, coriander, and marigold were used as biological pest control plants. Carrots and black nightshade were grown on the mound bed, while kales, swiss chard, coriander, onions, capsicum, and marigold were grown on the second wall and primary tower vertical gardens. Observation guides was the data collection tool that was used at this stage. The project was within the school compound and site selection was informed by identifying a location that paused limited learning interference for students and allowed for maximum vertical vegetable gardening learning opportunity for the targeted population. Secondary schools follow pedagogical approach to learning; therefore, their measure of learning was through skills acquisition. On the other side, smallholder farmers follow andragogy as an approach to learning and their measure of learning was on the use of vertical vegetable gardening technologies to solve the problem of limited vegetable production through technology acceptance.

Closure survey

The closure survey was conducted to assess the change caused by the intervention. The change was to inform on the feasibility of the approach while comparing it to an ideal/tested agricultural extension approach. The following key indicators were used to assess the feasibility of agricultural extension through schools: the ability to allow for multiple delivery channels (this indicator was also assessed during the intervention); the change in level of technology acceptance; the replicability of each vertical gardening technology at home; and the scope of learning for agricultural extension activity in secondary school that would recommend the approach suitable for a guiding policy for implementation

Questionnaires and observation guides that were used at the baseline survey were also used at the closure survey to assess the change. Observation guides were used to assess the level of skills acquisition and use for each technology that was used in the study; individual technology acceptance and overall level of vertical gardening technology acceptance; and the number of vegetables grown in vertical vegetable gardens at home. The vegetables that were used in the study were the reference points during data collection at this stage. Questionnaires at the closure survey focused on changes that were caused by the intervention based on the findings of the baseline survey. The closure survey was conducted during the fifth month of the project.

Population of the Study

The study targeted youths in their first, second, and third year of study in secondary schools and smallholder farmers in Teso South Sub- County, Busia County. Students in their fourth year of study were exempted from the study as they were preparing for the final secondary school education exam. Since the study aimed at assessing the extent to which the youths could be used in the dissemination of agricultural information to smallholder farmers, the target population of smallholder farmers consisted of either the parents or guardians of each of the targeted youths in the four sampled schools. The four schools had a total population of 530 youths in their first, second, and third year of study in the four sampled schools. The accessible population was 196 youths and 196 smallholder farmers.

Sample Size and Sampling Procedure

The study used purposive sampling to select four-day secondary schools within Teso South Sub County. Day secondary schools were preferred for the study since the youths in day schools were able to translate and practice the learned skills in vertical vegetable gardening at their homes and extend the same to their parents or guardians. Purposive sampling for the four schools was suitable for the study due to their proximity to the already established three sister strata demonstration plots near the schools. Three sister strata were part of Education and Training for Sustainable Agriculture and Nutrition in East Africa (EaTSANE) Project that supported the study. It was the practice of surrounding crops with forages. There were active demonstration plots next to the schools that were selected. Therefore, the community and got a chance to learn from the demonstration plots in the community and the schools. Using Yamane's formula, the sample size of the students was calculated (Israel, 2013).

$$n = \frac{N}{\left(1 + \ (Ne^2)\right)}$$

Where n= Sample size, N = Population size, e = the error at 5%

$$\frac{196}{\left(1 + 196(0.05^2)\right)}$$

= 131.5436 rounded off to 132 Youths

A complete list of registered youths in the four-day secondary schools was obtained from the Ministry of Education in Teso South Sub County. Systematic random sampling was used to select 132 youths from the first, second, and third year of study in the four schools. The names on the list in each school were reorganized to remove biases. A skip factor was established for each school, depending on the accessible population size in the four schools to determine the sample size. The starting point was determined randomly. 33 youths per school were selected to participate in the study and be part of the YFCK formed in each school. The sample size of farmers was purposefully selected from the accessible population of the students. Since the study aimed at assessing the extent to which the youths could be used in the dissemination of agricultural information to smallholder farmers, the accessible population of smallholder farmers consisted of either the parents or guardians of each of the targeted youths in the four sampled schools. The sample size of 12 smallholder farmers who participated in the FGD was randomly selected from the list of 132 smallholder farmers that were already sampled.

Instrumentation

Questionnaires, FGD, observation guides and interview guides were used to collect data during the three phases: the first phase collected data for the baseline survey, the second phase collected data during the intervention, and the third phase collected data at the closure survey. The data collected in the first phase was the baseline survey, which identified the gaps that informed the training manual preparation and suitable intervention. The intervention was rolled out after the analysis of data from the baseline survey. Both qualitative and quantitative data had equal dominance and were collected concurrently at each phase. The study was conducted on a single group using the same set of data collection tools at different periods.

The questionnaires were self-administered. However, guidance was given to respondents who had challenges with reading and writing. Smallholder farmers and youths completed the same survey at the baseline and closure survey. The observation guides were used at the baseline, during the intervention, and at the closure survey to collect data. FGD were only done at the baseline survey. They were audio recorded to allow for transcription. The observation guides and FGD data were collected by the researcher.

Data Analysis

The Statistical Package for Social Sciences (SPSS) (version 22) was used for statistical analysis, and results were accepted at $P<0.05$. During the analysis, Wilcoxon signed-rank test (inferential statistics) and descriptive analysis were used to analyze quantitative data. Wilcoxon sign-rank test was used for comparison of baseline and closure survey. Qualitative data were analyzed using thematic analysis. Descriptive analysis was done using means, frequencies, and corresponding percentages. Tables were used in data presentation. Data from baseline and closure surveys for individual respondents was collected in pairs for complete analysis at the closure survey.

Ethical Considerations

Information from the respondents were treated as confidential, and the data given were used in a format in which the individual respondents were not identifiable.

The respondents were made aware of their guaranteed confidentiality. Their consent was obtained before the study commenced. The researcher's behavior was very responsible and respectful of the respondents, and the responses from respondents were received with a lot of respect and clarifications sort with immerse humility. Each questionnaire was labeled by the use of numeric numbers to protect the identity. Where photographs were taken, their subsequent use was done after seeking permission from the respondents.

RESULTS

Socio-demographic Characteristics of the Study Population (Youths and Smallholder Farmers)

Majority (85%) of the smallholder farmers' respondents were female, with a mean age of 50.3, and the majority, at 45.6%, had primary school education as the highest level of education attained. Age as a variable was categorized into two, youths below 35 years and adults above 35 years. There were also more female (58.4%) than male (55.9%) student respondents. The level of learning of the youths showed that the majority (45.6%) were in their third year of study.

The baseline survey results revealed that 77.6% of respondents relied on farming as their primary source of income, and 86% grew vegetables in open fields. The average size of land under farming was 1.6 acres, with 0.3 acres allocated for vegetables. Sustainable vegetable production technologies, for example, green houses and vertical gardening, were less appreciated by the respondents at 0% and 1%, respectively, at the baseline survey. Moreover, the majority of the respondents got the vegetables they consumed at home from their farms. This accounted for 77.6 % of the total respondents as summarized in Table 1. The responses in Table 1 were obtained from the students and smallholder farmers questionnaires.

Table 1. Characteristics of Smallholder Farmers and Youth (n = 125).

Characteristics	n	%
Farmers		
Gender		
Male	40	32.0
Female	85	68.0
Age		
<35	8	6.4
>35	117	93.6
Mean age (SD)	50.3	9.2
Education level attained		
Post graduate	1	0.8
Bachelors/ Diploma	12	9.6
Secondary education	42	33.6
Primary education	57	45.6
Did not go to school	13	10.4
Main source of income		
Farming	97	77.6
Business	20	16.0
Employment	8	6.4
Sources of vegetable consumed at home		
From own farms	97	77.6
Bought from market	16	12.8
Supplied in kind	12	9.6
Method of vegetable production		
Open field method	108	86
Kitchen gardening	66	53
Vertical vegetable gardening	1	1
Greenhouse	0	0
Average size of land under farming	1.6	
Average size of land under vegetable production	0.3	

Youths		
Gender		
Male	52	41.6
Female	73	58.4
Age		
Mean age (SD)	17.9	1.6
Year of study		
First	26	20.8
Second	42	33.6
Third	57	45.6

Source: Baseline Survey Data

Findings from Baseline Survey on Training Needs

The baseline survey findings showed that; (i) the concept of vertical gardening as a vegetable production technology was new to the respondents, as 1% of the respondents were aware of vertical vegetable gardening, (ii) agricultural extension and its role in food and nutrition security were new to 83% of the youths in schools (iii) the schools had agriculture schools' farms, but the farms were only available for practice and learning for students in their fourth year of study, (iv) outdoor hands-on agricultural learning activities and efficient use of empty spaces within the school compound for agricultural activities were also lacking, (v) there was no active YFCK in the four sampled schools to provide an avenue for outdoor agricultural learning. On agricultural extension through schools; (vi) there was no evidence on how the schools allowed smallholder farmers to access agricultural information from school farms, (vii) assessment of awareness of learning opportunities in school farms showed that 95% of the smallholder farmers were not aware of the learning opportunities that existed in school farms, hence 90% of the smallholder farmers rarely visited the schools. A survey on access of agricultural information on vegetables from public agricultural extension showed that there was minimal public agricultural extension on vegetable production and consumption. Smallholder farmers physically interacted with extension service providers (61%). However, the ease of accessing agricultural extension on vegetable production was somehow difficult (42%), and hence smallholder farmers rarely (48%) got to interact with extension service providers as summarized in Table 2. There were no agricultural extension smallholder farmers' referrals to school farms for learning by public agricultural extension service providers. Findings of the FGD showed that smallholder farmers obtained information on vegetable farming from fellow farmers through farmer-to-farmer extension and they preferred indigenous vegetables over exotic vegetables.

Table 2. Access to Agricultural Extension at the Baseline Survey.

Item	Response	n	(%)
Interaction with field extension officers	Physically	76	61
	Through phone call	11	9
	Through SMS	3	2.4
	Facebook	35	28
Ease of accessing agricultural extension services	Very difficult	34	27
	Difficult	31	25
	Somehow difficult	52	42
	Not difficult at all	8	6
Frequency of interaction with agricultural extension officers	Always	7	6
	Sometimes	35	28
	Rarely	60	48
	Never	23	18

Dissemination of Agricultural Information before and after the Intervention

There was a significant change in the dissemination of agricultural information by youths in secondary schools.

At the closure survey, dissemination of information by youths from school demonstration plots improved from mean = 2.81, *(SD = 1.183*) at the baseline to mean = 2.24 *(SD = 1.011)* at the closure survey, *P = 0.0001 as seen in Table 3.* There was also a significant change in the purpose of visit of smallholder farmers at *(P=0.042)* to schools and increase in agricultural extension referrals by youths in schools for learning at *P=0.000* at the baseline and closure survey. This significantly increased access to vertical vegetable gardening information.

Table 3. Dissemination of Agricultural Information before and after the intervention.

Item	Transfer of Information						
	Baseline survey			Closure survey			
	Mean	SD	Mode	Mean	SD	Mode	*P*
Vertical gardening demonstration plots	2.81	1.183	4	2.24	1.011	2	0.000
Any agricultural information given in school	2.39	1.244	1	2.03	1.157	1	0.31
Field days	3.22	1.084	4	3.29	1.007	4	0.23
Agricultural workshop	3.84	0.429	4	3.86	0.396	4	0.317
Agricultural shows	3.48	0.921	4	3.48	0.921	4	1
Agricultural exhibitions	3.75	0.631	4	3.75	0.631	4	1

Scale measure for mode, 1=often, 2=sometimes, 3=rarely and 4=never, *(1) Often means at least once a week; (2) Sometimes means at least once a month; (3) rarely means once in a term (4) have never*

Assessment of the Feasibility of the Approach Based on the Findings

Assessment of the feasibility of the approach focused on the following;

1. *Multiple delivery channels: from* the findings, channels of communication were (i),youths in schools directly disseminated the information to smallholder farmers as they tried the technologies at home; (ii) through their YFCK, youths in schools utilized forums such as school annual general meetings, field days, and agricultural shows to share their work with the public; (iii) the schools being communal institutions, the demo plots in schools became learning opportunity for anybody who happened to visit the school.
2. *Change in level of technology acceptance: At* the closure survey, there was a significant change in the overall level of vertical vegetable gardening technology acceptance, at *P = 0.000* from 1% to 22% of smallholder at the baseline and closure surveys. There could be more beneficiaries that got vertical gardening information from the schools other than the targeted population since the schools are communal institutions.
3. *Replicability of individual vertical gardening technologies used in the study:* Among the three vertical gardening technologies that were promoted, second wall and primary tower performed well, while mound bed had low technology result demonstration. The gunny bags (second wall and primary tower) that were facing the east direction thus receiving morning sun rays and shade in the afternoon performed better than the structures that were receiving sun rays in the afternoon because they were facing west direction as seen in Figure 2.

   While assessing the extent of information dissemination on individual technology acceptance using the observation guide, majority of the respondents (90%) preferred vertical gardening using the second wall technology, with 10% using the primary tower and 0% using the mound bed. 10% of smallholder farmers who appreciated the use of the primary tower adapted the technology. Among the vegetables that were used for the purpose of learning, kale (*Brassica oleracea*) and black nightshade (*Solanum americanum*) were the only vegetables that respondents tried growing using vertical vegetable gardening technology at home after the intervention. The vegetables were indigenous vegetables.
4. *Scope of learning of agricultural extension activity-* From the study, the baseline survey, participatory vertical vegetable gardening training, and closure survey were all done within five months, which

was within the secondary school learning calendar. Vegetable production is within the scope of secondary school learning. The study adopted the participatory learning model, which enhances the use and application of knowledge as knowledge brokerage to a scope recommended for secondary school education level. The interactions of youths in schools and the farming community offered a wide geographical area for an extension activity. Schools are communal and strategic, hence the offered learning opportunity to many people.

Figure 2. Vertical Vegetable Gardens after Establishment.
Source: Picture taken by the researcher during the implementation of the intervention (Figure 2).

DISCUSSION

Numerous studies have investigated how to improve agricultural production through agricultural extension despite the challenges facing the sector. This study focused on identifying alternative approaches that can be used by agricultural extension to improve access and use of agricultural information by smallholder farmers. Some of the challenges that affected vegetable production through access to vegetable production information identified at the baseline survey showed need to diversify into other applicable strategies and approaches as some of the challenges are far from being solved as seen in Table 2. While the role of youths in agricultural extension has been investigated before, the study compared the role of youths in secondary schools in agricultural extension on vertical gardening to an ideal agricultural extension approach that has been tried. The bottom-up agricultural extension approaches advocate for farmer participation in knowledge and skills acquisition (Osumba *et al*., 2021). The participatory approach to training on three vertical vegetable gardening technologies intervention that was used in the study showed significant increase in accessing information on vegetable production at the closure survey. At the baseline survey, 1% of the respondents were aware of vertical vegetable gardening as a vegetable production technology. However, by taking part in establishing, field management, and harvesting the produce in the vertical vegetable garden demo plots in schools, the students acquired skills and were able to translate the same at home as seen in Table 3 on the change of agricultural information transfer.

Based on resource availability at home, the hands-on approach triggered their creativity and gave both the students and smallholder farmers a chance to observe, reflect, and learn, and they were able to tell the difference between the recommended new practice and the traditional practice. According to the study done by Kansanga *et al*. (2021), farmer-to-farmer participatory training on soil and land management (SLM) improved access to knowledge on SLM that significantly bridged the gap low agricultural extension in Malawi. The ultimate results of the participatory approach to vertical vegetable gardening were change in the level of technology acceptance by smallholder farmers from 1% to 22% at the baseline and closure surveys. These findings agree with the study done by Bourne *et al*. (2021), which showed that a participatory approach to agricultural extension enhances adoption of technologies compared to other traditional approaches. The change in the level of acceptance was largely attributable to the multiple delivery channels that the approach of agricultural extension through schools created. At its conception, the study targeted youths as

both recipients and providers of agricultural information. However, during the intervention, the findings showed that the presence of demonstration plots in schools attracted a larger audience for learning than the targeted population. Moreover, the agricultural extension approach in schools targeted youths in schools and the farming community, which offered a wider geographical location through the expected interactions between the youths and their immediate community. Therefore, the approach proved to offer a cost-effective way to reach a wide range of smallholder farmers to promote vegetable production.

Narrowing down to individual technology level of acceptance, the findings revealed that, the participatory training on vertical vegetable gardening intervention enabled the participants evaluate the difference among the three technologies based on their performance and characteristics. The results showed that among the three technologies that were used in the demo plots, the second wall technology was the most appreciated technology (90%) by smallholder farmers. Its simplicity and good performance during the five-month period, made it easier for the youths in schools to repackage the information and disseminate it to smallholder farmers. At 10%, the primary tower was adapted as a vertical vegetable gardening technology. The smallholder farmers used a column of ballast at the center of the gunny bag instead of using a PVC pipe. This significantly reduced the cost of establishing the gunny bags. Thus, explaining the importance of participatory learning and technological simplicity, as they allow for improvisation (De Roo *et al*., 2019). However, none of the respondents who participated in the study appreciated the use of mound bed as a vertical vegetable gardening technology. Despite its simplicity in construction, it still did not attract farmer interest because of its lower performance compared to the other two technologies. The low performance probably led to the low dissemination of mound bed information by youths to smallholder farmers. The overall results showed that the technologies were replicable and the targeted respondents could modify the technologies to fit their situation. Klerkx *et al*. (2017) explained the benefits of particptory approaches when translated to intitutional conditions at different levels as they would likely enhance technology uptake.

Regarding the scope of learning of agricultural extension, the training need and mode of learning was within the scope of the secondary school agriculture curriculum. Vegetable production and consumption topics are within the secondary school agriculture curriculum and is also a global key area in food and nutrition security. The clear identification of the training need and scope probably increased proper targeting of information which in return enhanced its diffusion. This also made the approach timely and it easily fitted into the tight school schedule, increasing acceptability by the school administration and the students, as well as ease of accessing information by both youths and smallholder farmers. As a result, there were increased use and application of the knowledge gained from the demo plots offering immediate impact on the farming community. Previous studies have shown that proper identification of scope of agricultural extension activities enhance access to information and other developmental opportunities; allow for use or application of the information, and offer almost immediate impact to the targeted beneficiaries (Norton and Alwang, 2020; Beaman *et al*., 2021).

Another aspect of scope of learning for agricultural extension activities is time frame. It was necessary to assess time frame of agricultural extension through schools since the approach targeted youths in schools where learning activities follow specified guidelines and time frame. In the study, planning and preparatory activities, implementation, management, and harvesting of the produce by the youths, was completed within a short period. This made it easier to work with the youths, allowing them to try the technology at home and assess the outcome. It also allowed smallholder farmers access other essential information on vertical gardening, such as reliable sources of improved agro-gunny bags and vertical garden management information within the life of the project. While “rethinking on technological change on smallholder farmers” Glover *et al*. (2019) explained the importance of framing of agricultural extension activities from conceptual to technological change evaluation as they play a key role in enhacing impact to the farming community.

Limitation of the study

Secondary schools education (pedagogy) follow a specified curiculum implementation guidelines while on the other hand, agricultural extension follows andragogy as a form of learning. The use of different learning approaches made it quite difficult for

agricultural extension to seamlesly fit into the school tight schedule. Site selection for demostration was another limitation as it can cause direct interefeence with the learning process of students in secondary schools.

CONCLUSIONS AND RECOMMENDATIONS

The participatory approach to learning using vertical vegetable gardening among youths through YFCK increased access to timely skills and knowledge on vertical vegetable gardening information among smallholder farmers. The smallholder farmers got a chance to learn from school demonstration plots whenever they visited the schools and through student's trials at home. During implementation, the activities that were done by YFCK gave youths in schools a stimulus of their role in agriculture for agriculture development as they gained the skills. Moreover, the approach also offered insights into learning and youth empowerment in rural communities; hence, it is a feasible approach to be used by agricultural extension. Besides, the approach of engaging youths in schools in agricultural activities aligns well with the current competency-based curriculum in Kenya, making it flexible and easily fit into the school calendar. Therefore, in the policy area, the study suggests that, through YFCK, the use of youths in schools for agricultural extension as both providers and recipients of agricultural information be mainstreamed in National Agriculture Sector Extension Policy (NASEP) and other extension service delivery implementation strategies to improve agricultural extension service delivery.

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