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Sustainability and Gender Implications of Peri-urban on-farm conservation of crop resources for food and agriculture

Alice A. Oluoko-Odingo

Department of Geography and Environmental Studies, University of Nairobi

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Corresponding Author
Alice A. Oluoko-Odingo
Email Address: alice.odingo@uonbi.ac.ke

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ABSTRACT

Plant Genetic Resources for Food and Agriculture (PGRFA) which form a large proportion of biological diversity are under threat. Sustainability of such crop resources can only be assured through their ex situ and/or in situ (on-farm) conservation. Farm households (market gardens as referred to in the article), play a key role on in situ conservation. This article recognises this important contribution of on-farm conservation of crop resources in urban and peri-urban areas and examines the effects of household size and reproductive health services on-farm crop conservation as well as strategies in place to deal with the issue of increasing household size. Gender equity and equality is underscored in ensuring manageable household population and the conservation of PGRFA. In this article, crop resources diversity, productivity and sustainability is a function of socio-cultural-economic and political factors and biophysical variables in accordance with the human-ecological systems approach. The study was carried out in peri-urban area of Nairobi using a sample size of 400 farms or market gardens. The main objective was to examine the effect of household size on crop resources conservation in peri-urban areas as well as measures taken by market gardens to reduce household size including gender implications of such efforts. The Chi-square statistic was employed in investigating whether there was any association between number of children (household size) and the conservation of crop resources (crop diversity within the farm) and also to establish an association between use of Reproductive health services (as a major population control mechanisms) and experiences of gender-based violence. In both cases, the null hypothesis of no association was rejected. The findings showed that market gardens with fewer children were better in crop resources conservation, with more diversity found in market gardens with less than six children. The null hypotheses tested established an association between household size (number of children) and crop resources conservation as well as methods of population management (use of Reproductive health services) and gender-based violence. Education and awareness creation on the importance of fewer children on crop resources conservation and sustainability and the need to reduce gender-based violence formed part of the recommendations.

1. Introduction

Crop plant is plant or plant product that is grown and harvested for profit or subsistence. Depending on their uses, crops are classified into six groups: food crops, feed crops, fibre crops, oil crops, ornamental crops and industrial crops (National Geographic 2019). Peri-urban on-farm conservation of crop resources is one way of ensuring food security and sustainability of food and agriculture. Within urban and peri-urban areas, there is continuous loss of crops in terms of species and diversity to various land uses: residential, industrial, and waste management, among others. Crop resources diversity refers to genetic diversity within each crop and the number of species commonly grown. Loss in crop diversity is a threat to food security and agricultural development, with the main culprit being the increasing and high human population density in urban and peri-urban areas of major cities. This calls for action to tame the eminent challenge to future food security. This article is aimed at investigating this important link between crop resources conservation (measured by the number of crop plants grown by each farm household/ market gardens) and increasing population (household size using number of children in each farm household). It was assumed that crop diversity is directly related to the number of crops grown in each market garden, whereby poverty of crop plants is a sign of low crop diversity.

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The study further examined how the various farms or market gardens were addressing the issue of increasing human population densities as well as the outcomes of such actions.

This article is based on a fieldwork research carried out within peri-urban areas of Nairobi City though a mixed methods approach. The study adopted a human-ecological systems model as crop resources are impacted by both the natural and socio-cultural and political factors. The study established that there is an association between crop resources diversity and household size, with smaller household sizes having better performance in crop diversity conservation. Conversely, these small household sizes are epitomes of gender-based violence (GBV) which also had an association with the use of reproductive health services (RHS). As part of recommendation, there is need for awareness creation and education on the importance of managing household population for both food security and agricultural sustainability.

1.1 Natural Resource Conservation, Gender and Sustainability

Natural resources management is effective for the functioning of ecosystems. The ecological system resources provide humanity with food, fuel, medicines, fresh water, fisheries, air and water regulation- which are all vital for life support on the planet earth. The provision of these services is threatened by natural factors (climate change and biodiversity loss due to habitat fragmentation) and human factors (uneven human population densities, overgrazing and excessive harvesting, competition from exotics (planned or accidental), and changes in land use (deforestation and land clearance) (Westmoreland 1999). The reduction in biodiversity in agriculture has not been spared the loss. Thus the importance of conservation of habitats for sustainability of Plant Genetic Resources for food and Agriculture (PGRFA) through in situ or on-farm conservation.

In this Article, the concern is on food crops, mainly harvested for human consumption. These plant genetic resources ensure sustainability and environmental health as they provide ecosystems services: regulating services (climate and disease regulation, pollination and water purification), cultural services (recreational, spiritual, inspirational and education), and supporting services (soil formation and nutrient cycling) (FAO 2015). For cultivated crops, the household farm (market garden) provide the habitat, where the individual farmer takes the responsibility of conserving the crop resources. The sustainability of these crop resources would ensure future adaptability of cultivars and wild populations, preservation of data and traits for future agriculture, better use of genetic resources in commerce and biotechnology as well as conserving genetic resources for cultural purposes (Commission of Genetic Resources for Food and Agriculture 2009).The Commission of Genetic Resources for Food and Agriculture (2009) emphasized that rapid urbanization was creating an impact on the state of diversity. The Commission was categorical that steps should be taken to involve local communities to conserve or better manage crop diversity on-farm through effective policies, fairer incentives and closer coordination between agriculture and environmental sectors to assess the threats to in situ conservation of PGRFA. There is inadequate research regarding the relationships between crop resources conservation and gender.

The term gender may be used to imply socially constructed roles and responsibilities of women, men, girls and boys, which vary in space and time. The understanding of gender should be cognizant of the relations between women and men, which sometimes put women in sub-ordinate positions as assigned by cultures (Oluoko-Odingo et al 2016). If not well-balanced, gender relations have a potential to generate conflict among households and communities, particularly, where resources are limited with increasing demands as in the case of agricultural resources, which are shrinking with increasing needs for services. Balancing farm size with household size could provide a starting point (Oluoko-Odingo et al 2016). Mainstreaming gender equity and equality in farm ownership, farm operations and efforts towards population control is key in ensuring the conservation and sustainability of crop resources for food security and agriculture (Oluoko-Odingo 2019).

1.2 Theoretical and Conceptual Framework Model

This study used the human-ecological systems approach where the sustainability of market garden is seen as influenced by both the pre-existing ecosystem factors (climate, soils and other biophysical factors) and social-cultural and political factors (household size/population, education, technology, gender, and government policy, among others). All these factors work together to either sustain or destroy crop resources in the area. The study is more concerned with the human factors (household population) which influences both the ecological and human systems as shown in figure 1.

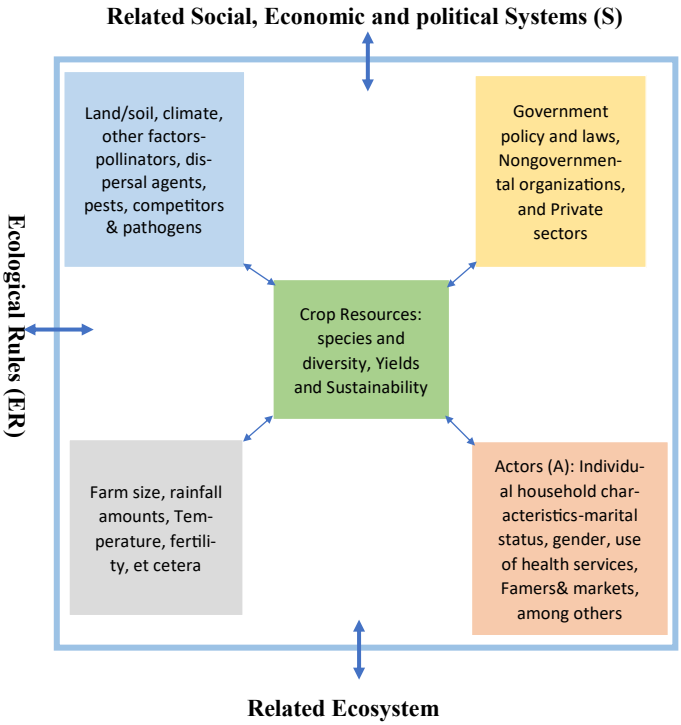

Figure 1: Human and Ecological Factors influencing Sustainability of Crop Resources
Source: *Author (2019)*

2. Methods

The study was carried out between 2017 and 2018 in Peri-urban areas of Nairobi Metropolitan city in Kenya (Machakos and Kajiado Counties) among market gardens (market gardens, farms or household farm as referred to in this research means those farms used to produce food for the market, besides family use and conservation efforts). The main objective of the study was to examine the effects of increasing human populations on crop resources conservation using the number of children in each household. Due to increasing loss of crop resources / shrinking numbers of cultivated crops in urban and peri-urban areas as a result of human settlement, industrial development and other land uses, the peri-urban area of Nairobi was preferred for the study. Machakos and Kajiado counties were selected as they are the main peri-urban areas receiving excess human populations from Nairobi city, while the number of children in each household was considered appropriate in this research as it did not require details about marital status. The study aims to answer the following questions: (i) which household sizes (small or large households; married, single or widowed) are most active in on-farm conservation of crop resources for agriculture? (ii) Are there any existing attempts to deal with increasing household population in the study area? (iii) What should be done to enhance gender equality in the conservation of crop resources for food and agriculture?. The first and second Questions are analysed quantitatively while the third one uses data from Focus Group Discussions (FGD) to provide responses as discussed during the fieldwork.

A sample of 400 households was selected randomly, 200 households from each County. The data was collected through questionnaires and Focus Group Discussions (FGDs) in order to understand how the number of children in each household influenced the crop diversity within that particular farm household. Secondly, the study examined any existing attempts to deal with increasing population within the household as this is important in the sustainability of crop resources.

The data was keyed into SPSS Software and subjected to descriptive statistical analyses (cross tabulations and chi-square statistic) to test the null hypotheses. The Chi-square statistic was employed in investigating whether there was any association between number of children (household size) and the conservation of crop resources (crop diversity within the farm) and also to establish an association between use of Reproductive health services (as a major population control mechanisms) and experiences of gender-based violence (which are counter-productive on efforts towards household population management). In both cases, the null hypothesis of no association was rejected. The data was presented on tables, charts and graphs. A number of recommendations have been put forward to enhance gender equity and equality and conservation of crop resources for future sustainability of food and agriculture.

3. Results and Discussion

3.1 Variation in Household size with Crop resources conservation

Households with 2 children (which had 26.44 percent of crop resources) were better in conservation of crop resources. This was followed by households with 4 children (19.91 percent), 3 children (17.48 percent) and 6 children (10.18 percent), respectively. These are shown in Table 1 and figure 2. It is these smaller household sizes that should be targeted for crop resources conservation efforts. It also means that efforts should be made to promote the smaller household sizes (fewer children) which do not seem to create pressure on crop resources for sustainability.

Table 1: Household size (Number of children) and Crop Resources

Household size	Crop Resources (frequencies)						
	Grains	Vegetables	Legumes	Fruits	Root crops	Total	Percent
No children	6	7	3	0	0	16	3.54
One (1) Child	15	12	11	1	1	40	8.85
Two (2) Children	45	58	10	6	1	120	26.55
Three (3) Children	38	26	10	2	3	79	17.48
Four (4) Children	22	30	30	5	3	90	19.91
Five (5) Children	12	6	28	0	1	47	10.40
Six (6) Children	13	11	20	2	0	46	10.18
Seven (7) Children	2	5	7	0	0	14	3.10
Total	**153**	**155**	**119**	**16**	**9**	**452**	**100**

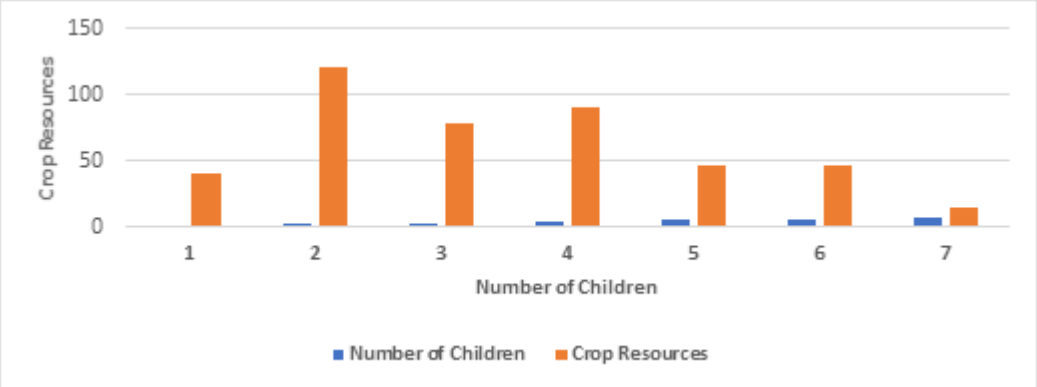

Figure 2: Household size and crop resources (frequencies). *Source: Field data (2017)*

Regarding crop resources within market gardens, vegetables had greater diversity, while grains and fruits had least diversity. As grains form the bulk of food among households, it would be important to increase their diversity by introducing more nutritious and extreme weather tolerant crops like sorghum and millet among others. Vegetables which showed greater diversity is better placed in terms of sustainability. It could also mean that their demand is greater within the peri-urban area, thus encouraging the diversity.

Figure 2 indicates that household size could be inversely proportional to crop resources conservation or the smaller the household size, the more the crop resources diversity conserved. Thus, higher number of children was not good for the conservation of crop resources. The farmers with seven (7) children and above tended to grow mostly maize and beans in combination with spinach, kales, tomatoes, saga, terere/ amaranth and cabbage (vegetables), and green grams (legumes) and mangoes and avocadoes (fruits). In this study, the number of children was used to measure the household size. As a result, it would be important to minimize the number of children in each household size as a step towards crop resources conservation.

The crop diversity was as shown in Table 2.

Table 2: Crop Resources Diversity

Crop type	Diversity
Grains	Maize and wheat
Vegetables	Onions, spinach, cowpeas, kales, manage (African night shade), Tomatoes, Spider plant/ Sagaa, Coriander, Capsicum, Green pepper, Pigeon peas, Aubergines, Terere/Amaranth, herbs, cabbage and pumpkins
Legumes	Beans, Cow peas, Green grams, Pigeon peas, Green peas and French beans
Tubers/Root crops	Potatoes and Cassava
Fruits	Melons, Apples, Mangoes, Avocadoes, Oranges and Pawpaw

Source: Field data (2017)

Only a few farmers grew fruits, thus the need to introduce more fruits species in the area. These are shown in figure 3.

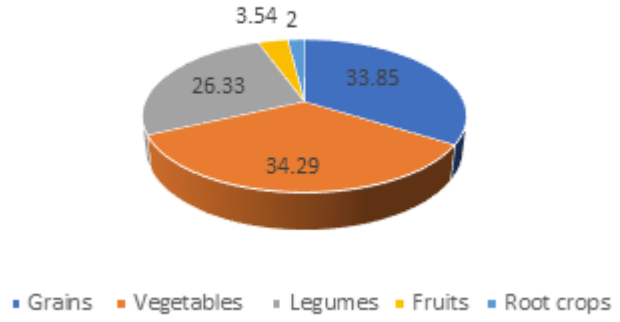

Figure 3: Diversity of crop resources in the study area
Source: Field data (2017)

The following hypothesis was tested to establish any association between household size (number of children 1-6 children) and crop resources (number of crops in market gardens) conservation (table 3).

Table 3: Variation in Household size with crop resources

Number of Children	Total			
	Grains and Root crops	Fruits and Vegetables	Legumes	Total
1	16	13	11	40
2	46	64	10	120
3	41	28	10	79
4	25	35	30	90
5	13	6	28	47
6	13	13	20	47
Total	**145**	**143**	**109**	**422**

Source: Field data (2017)

Note: Grains were combined with root crops and fruits with vegetables as root crops and fruits did not meet the requirements for chi-square singly.
H0: There is no association between household size (number of children) and conservation of crop resources (grains and root crops, Fruits and Vegetables and legumes) in the study area.
The Expected frequencies (table 4) are as follow:

Table 4: Expected frequencies for Household size and crop resources

Number of Children	Total			
	Grains and Root crops	Fruits and Vegetables	Legumes	Total
1	16 (14.60)	13 (15.07)	11 (10.33)	40
2	46 (43.79)	64 (45.21)	10 (31.00)	120
3	41 (28.83)	28 (29.77)	10 (20.41)	79
4	25 (32.84)	35 (33.91)	30 (23.26)	90
5	13 (17.15)	6 (17.71)	28 (12.14)	47
6	13 (16.79)	13 (17.33)	20 (11.88)	46
Total	**154**	**159**	**109**	**422**

Source: Author (2019)

Chi-square (χ^2) = $\sum(O-E)^2/E$ = 73.94.

Degrees of Freedom (6-1)(3-1) = 10.

Critical $\chi^2 = \chi^2_{(10,005)} = 3.94$

Since 73.94 > 3.94, the null hypothesis was rejected and a conclusion made that there is an association between number of children in a household and conservation of crop resources. Earlier on there was already a finding that smaller households were better for conservation and sustainability of crop resources, thus the need to minimize the number of children in each household.

3.2 Gender and Crop Resources Conservation

The section on gender examined implications of gender on crop resources conservation in relation to marital status and use of reproductive health services. The variation of gender with marital status showed that the majority of sampled market gardens or farm households were married (80 percent), while 10.5 and 1.53 were singled and widowed, respectively. The rest did not answer the question. These responses are shown in table 5 and figure 4.

Gender	Married	Single	Widowed	No Answer
Female	133	14	4	
Male	180	27	2	31
Total	**313**	**41**	**6**	

Source: Field work data (2017)

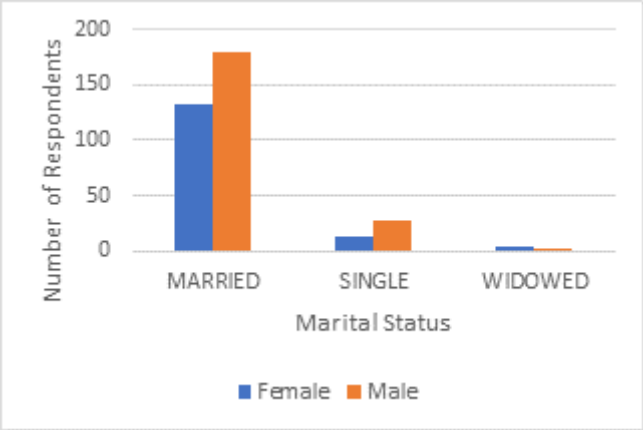

Figure 4: Variation in Gender with Marital Status

Source: Field data (2017)

Figure 4 shows that most households studied were married. Besides, there were more male single farm households (market gardeners) , with more female widowed market gardeners). In order to verify whether there is gender equality or inequality in relation to marital status, the Chi-square test of no difference using data on table 5 is carried out. The Expected frequencies are as shown below (table 6):

Table 6: Expected Frequencies on the Relationship between Gender and Marital Status

Gender	Married	Single	Widowed	Total
Female	133 (131.29)	14 (17.70)	4 (2.52)	151
Male	180 (181.71)	27 (23.80)	2 (3.48)	209
Total	**313**	**41**	**6**	**360**

Source: Author (2019)

Chi-square at 3 Degrees of Freedom (critical) is 0.352 < 2.5683 (calculated $\chi 2$), thus the null hypothesis of no difference is rejected and a conclusion made that there is a difference in gender and marital status. Thus showing inequality in relation to gender and marital status.

Married households had all the crops (29 different crops or 51.79 percent of the crop resources sampled). Table 7 shows the variation of crop resources with marital status.

Table 7: Variation of crop resources with marital status

Marital Status	Crop Resources	Total number of crops	Percent
Married	Grains (Maize and Wheat), Legumes (Beans, Cowpeas, Green grams, Green peas, Pigeon peas and French beans), Vegetables (Onions, Spinach, Cow peas, Pumpkins, Kales, African night shade/Managu, Tomatoes, Spider plant/ Sagaa, Coriander, Green pepper, Brinjals/ Aubergine, Amaranth/ Terere, Herbs and Cabbage), Fruits (Melons, Mangoes, Avocadoes,, Bananas, oranges, pawpaw), and Tubers/Root crops (Cassava and Potatoes)	29	51.79
Single	Beans, Maize, Onions, Spinach, Cow peas, Pumpkin, Kales, Managu, Tomatoes, Bananas, Green pepper, Aubergine, French beans, Amaranth, Napier grass, cabbage and potatoes.	18	32.14
Widowed- Female	Beans, maize, cow peas, kales, tomatoes, coriander and green peas	7	12.5
Widowed- Male	Beans and Maize	2	3.57
	Total	**56**	**100**

Source: Field data (2017)

Widowed male market gardeners or farms had poverty of crop diversity, whereby they only produced beans and maize which can be disastrous for sustainability of crop resources for food and agriculture.

Table 7 shows that women play an important role in the conservation of crop resources, such that even after they are widowed, they still continue with their farming operations. The married households performed best. This could be due to farm security as is normally held by men and therefore households can experiment with both seasonal and perennial crops. Greater diversity existed in vegetables compared to other crop resources (grains and fruits). The results showed that vegetables are better placed to deal with calamities that frequently encounter crops (like droughts, pest and disease) as the diversity is relevant in developing new crops that can cope with adverse conditions, hence were more sustainable. Conversely, those crop resources with less diversity, may not have adequate material for research into new crops that can withstand unexpected and adverse conditions of droughts, pest and diseases, among others, thus compromising of sustainability of future food security and agriculture.

Oluoko-Odingo (2019) working in the same region also found out that women were beginning to own land and this could improve diversity within farms as their marital status would no longer determine crops that women can grow.

It would be important to introduce some early maturing fruits to supplement household diets while also increasing diversity in the area.

About 51 percent of the market gardens/farm households used reproductive health services, against 48.39 percent who did not use. The table (Table 8) shows that Reproductive health services were mostly used in smaller households with less than six (6) children, hence the importance of investigating the relationship between the household size and experience of GBV. For respondents who used Reproductive Health Services (RHS), they applied the safe days method, coils, implants, while others stated that they were either single or widowed. The respondents that did not use RHS were categorical that the children were a source of wealth, they do not have enough knowledge/ idea or information, it is not allowed by society or not good for society and simply they want more babies, thus the need to educate the community on the use of RHS.

The community were asked whether they have experienced any form of gender-based violence in their farming operations and table below (table 8) provides the responses:

About 5.5 percent of market gardeners or farms experienced gender-based violence. It should be noted that any experience of any percentage of gender-based violence (GBV) in the society is not acceptable, as most of the cases go unreported due to fear and intimidation. Table 8 shows that GBV is mostly experienced in smaller households (one to four children), yet it is these smaller households that have better conservation of crop resources for food and agriculture, thus showing a threat to conservation efforts. The GBV was more prominent in households with one (1) and two (2) children. In these households, there were more people using Reproductive Health services than those that do not.

The various types of GBV experienced include: Abuse, violation, fighting over property, discrimination, cruel treatment if there is no money, abuse in livestock markets, insults, due to men owning land, men use farm produce for their own benefit, or women are made to work for men. One explanation could be that in smaller households, the women are more aware of their rights and are willing to stand up for those rights, while their spouses have greater control over the women. The issue requires more research for clarification.

The experiences of GBV in smaller households led to the investigation of the link between reproductive health services and GBV, as it is again the smaller households that used these services as shown in table 9.

In order to deal with the gender-based violence, it would be important to create awareness and educate the community on the values for and against RHS for them to make informed choices. The null hypothesis was tested to establish any association between use of reproductive health services and GBV as shown in table 10.

H_0: There is no association between the Use of Reproductive Health Services and Experience of GBV (among households with 0 to 4 children).

Table 10: Variation in Household size and use of Reproductive Health services

Number of children	One child	Two children	Three children	Four children	Total
Yes (Use Reproduc-tive Health Services (RHS))	8	19	13	18	58
No (Do not use RHS)	6	17	16	11	50
Total	**14**	**36**	**29**	**29**	**108**

RHS- Reproductive Health Services. Source: Field data (2017)

The Expected frequencies are as shown in Table 11.

Calculated $\chi^2 = 1.91 > 0.325$ (Critical χ^2), thus the Null hypothesis was rejected and a conclusion made that there is an association between the Use of Reproductive Services and Experience of Gender-based violence. Since increases in population is a major problem for conservation of crop resources, this is an area that requires policy intervention through education and awareness to assist the communities understand the importance of household size on farm productivity and conservation of crop resources for food and agriculture. The smaller household sizes had better crop diversity compared to larger households and thus were sustainable in terms of food security and agriculture.

Table 8: Household size (Number of children) in relation to Experience of Gender-based violence

Number of children	0	1	2	3	4	5	6	7	8	9	10	11	15	16	**Total**
Yes/ Experience GBV	0	3	2	4	2	0	0	0	1	0	0	0	0	0	**12**
No/ Do not Experience GBV	7	13	56	48	36	16	15	5	6	1	0	2	1	1	**207**

Source: Field data (2017)

Table 9: Variation in household size with use of Reproductive Health Services

Number of Children	0	1	2	3	4	5	6	7	8	9	10	11	15	16	23	Total	%
Yes	4	8	19	13	18	4	2	2	3	3	-	2	1	1	0	80	51.61
No	7	6	17	16	11	8	5	0	2	2	-	0	0	0	1	75	48.39

Source: Field data (2017)

Table 11: Expected Frequencies- Household size and use of RHS

Number of children	1	2	3	4	Total
Yes	8 (7.52)	19 (19.33)	13 (15.57)	18 (15.57)	58
No	6 (6.48)	17 (16.67)	16 (13.43)	11 (13.43)	50
Total	**14**	**36**	**29**	**29**	**108**

Source: Data analysis (2019)

Degrees of freedom will be (Row-1) (Column-1) = (2-1)(4-1)=3.

Critical χ^2 (3,005) = 0.352

Calculated χ^2 = $\sum$(O -E)2/E, Where O and E are Observed and Expected Frequencies, respectively.

3.3 Steps to Improve Gender Equality in Market Gardens and in Peri-Urban areas of Nairobi City

The following responses were obtained regarding the necessary steps to be taken to enhance gender equality among market gardeners.

i) Hold workshops and campaign against gender violence and discrimination (70 percent),

ii) Organize empowerment programmes for women (25 percent),

iii) Educate the society, employ more women in farming, have equal rights for women and men, improve women's participation in market gardens, allow women to have livestock and hold seminars to campaign against gender inequalities (5 percent).

Education and equal opportunities were more valued as an aspect of enhancing gender equality in market gardens and in society in general and for improved crop resources conservation. Only a few felt that having women in leadership positions will impact gender issues in market gardens and society, thus showing that at the community level, the communities have not felt the differences in gender equality that come with women leadership.

4. Conclusions

The first null hypothesis tested was to establish an association between household size (number of children) and conservation of crop resources (grains and root crops, fruits and vegetables, and legumes) in the study area. The null hypothesis was rejected and a conclusion made that there is an association between the two variables. The results indicate the need to address the issue of increasing household population if food security and sustainable agricultural production is to be achieved. This can be done through incentives, like safety nets for smaller number of children which are lost should the numbers of children explode. The second null hypothesis tested was to establish an association between the use of reproductive health services and gender-based violence. The null hypothesis was rejected and a conclusion made that there is a relation between the two variables. It is not admissible to have any form of gender –based violence and thus, steps should be taken to address the issue as it is a threat to sustainable food security and agriculture. As a result, it would also be important to investigate further whether these results are unique to Nairobi city or are applicable to other peri-urban areas. Additional recommendations are as follows:

Policy makers to create awareness and educate community on RHS. Besides, there should be efforts to create awareness on rights and empowerment to reduce the violence, as well as frequent campaigns against GBV in the community (for both women and men) to improve farm productivity. Further, it would also be important to introduce some early maturing fruits to supplement household diets while also increasing diversity in the area. A campaign against GBV in the community (for both women and men) is required to improve farm productivity. Further, Policy makers should assist in relating women leadership and reduction in gender inequality, while also appreciating market gardens as an important area of policy development to improve livelihoods, while also supporting the conservation of cultivated crops.

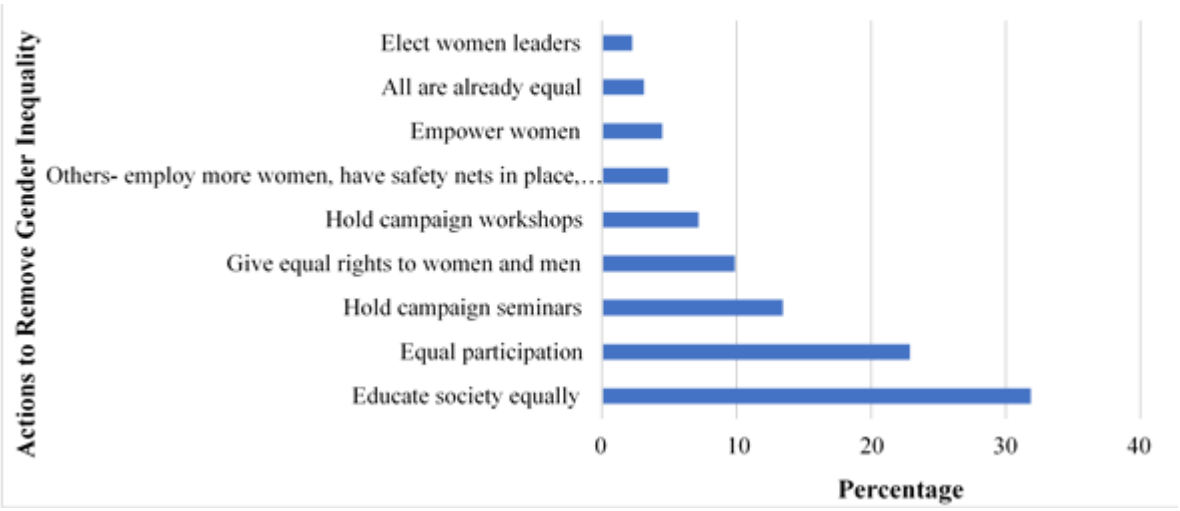

Figure 5: Actions for Improving Gender Equality in Peri-urban areas of Nairobi City

Source: Fieldwork (2017)

A possible area for further research could be to study the link between Education of the farmer and conservation of crop resources. Further research is also required to establish a relationship between education of the farmer and use of the Reproductive health services.

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