E-ISSN: 2710-2572
2022: Vol 4, pp 1-15. https://doi.org/10.51986/ijrcs-2022.vol4.01
Interdisciplinary Journal of Rural and Community Studies

Influence of Post-Harvest Technology on Food Security in Narok East sub-County, Kenya

Mmaitsi Lawrence Asige[1]
https://orcid.org/0000-0001-5963-927X
Maasai Mara University, Kenya
Obushe Dennis Omuse[2]
https://orcid.org/0000-0003-0704-3081
Maasai Mara University, Kenya

CORRESPONDENCE
Asige Mmaitsi Lawrence
Email: asige2014@gmail.com

DOI: 10.51986/ijrcs-2022.vol4.01

Abstract: *Crop yields have decreased globally due to declining investments in research and infrastructure, which are preconditions for food security. The study established the Influence of Post-Harvest technology on Food Security in Narok East sub-County, Kenya, which is a rural sub-County in Narok County. A descriptive research design was adopted by the study. The target population is comprised of 25078 households distributed proportionally in the four wards and is involved in different farming activities. A sample of 378 household heads was determined using the sample size determination formula. Primary data was collected using a questionnaire and an interview guide. Data analysis was done using descriptive statistics of frequencies, percentages and inferential statistics of correlation, ANOVA and regression analysis. The results were presented using frequency and percentages, tables and charts. The relationship between the variables was tested at a significant level of 0.05. The results show that there is a strong, positive and significant correlation between post-harvest technology and food security in the sub-County ($r = .606^{**}$ and p-value = 0.000). This implies that the relationship between the variables is very significant hence post-harvest technology is a strong determinant of food security in the study area. The study concludes that ANOVA model indicated a very significant and statistical relationship between post-harvest technology and food security. The study is beneficial to all the stakeholders in rural areas in Kenya who have consistently experienced food insecurity as it will provide appropriate data that will be used for policymaking.*

Keywords: Arid and semi-arid areas, Food security, Post-harvest Technology, Rural development.

1. Introduction

A number of global agreements like the World Food Summit (1996) and Millennium Summit (2000) have set goals and specific targets for collective action in reducing the incidence of hunger and food insecurity. Collectively, food insecurity reduces global economic efficiency by 2%–3% yearly (USD 1.4–2.1 trillion), with individual nation costs projected at 10% of GDP (Harrigan, 2014). According to Béné (2020), global food security is likely to remain a problem worldwide for many years if the world cannot formulate methods to control the situation. While agro-ecological approaches give some promise for yield improvement, increases in investment and policy reforms could significantly improve food security globally if well implemented. According to Béné (2020), the number of hungry people worldwide grew by reaching 1.3 billion in 2019.

Global economic changes, including rising global food and oil prices, have impacted worldwide food security with particularly severe effects in low-income countries (Gartland & Gartland, 2018). Africa has been struggling in one form or another with food insecurity for almost half a century due to a number of factors, including distribution obstacles, global climate change, lack of successful local agriculture and inability or disinterest to act by local officials (Kileteny & Wakhungu, 2019). Although most people would concur that each of these factors carries at least some logic, there is far less international accord on the best solution to the crisis. Ever since food aid to Africa began in the late 1950s, the predicament has been characterised as a supply affair. Inadequacy of successful and widespread agriculture in SSA led to the inability of local governments to provide enough food for their populations (Gwada *et al.*, 2020).

According to Brown (2016), Africa can accomplish Agenda 2063, if present day agriculture and expanded productivity and production are upgraded. The Comprehensive African Agricultural

Cite this article (APA):
Asige, M. L., & Omuse, O. D. (2022). Influence of post-harvest technology on food security in Narok East sub-County, Kenya. *Interdisciplinary Journal of Rural and Community Studies, 4*, 1-15. https://doi.org/10.51986/ijrcs-2022.vol4.01

Development Program (CAADP) is one of the continental frameworks under Agenda 2063 and it plans to enable African nations to eradicate hunger and diminish poverty by raising economic development through agriculture-led development as well as advancing increased national budget provision to the farming sector (Alawode, 2013). Through CAADP, African governments are required to expand investment level in agriculture by allocating at least 10% of the national budget to farming and rural development to accomplish agricultural development rates of at least 6% per annum (FAO, 2016).

In Kenya, food production is estimated to be lower than consumption due to increased population growth. According to Kenya Agricultural Research Institute (2020), annual agricultural production will need to rise by an estimated 75% from 2015 levels in order to meet consumption in 2030. In 2018, an estimated 1.7million people in rural areas and 5 million in urban areas were food insecure. Only about 2% of arable land in Kenya is equipped for irrigation. Farmers struggle to gain access to adequate seed, fertiliser and other inputs. The uptake of new technology, especially post-harvest technology, is low in Kenya, and this has led to dwindling harvests significantly (Poulton & Kanyinga, 2014).

According to the global food security index of 2017, Kenya is food insecure and was ranked position 86 out of 113 countries. A snap review of Kenya's food balance sheet shows that Kenya imports most of the basic food commodities, including wheat, Maise, Rice, Beans, Potatoes, sugar and Milk (M'Kaibi et al., 2017). According to Kivisi (2019), pre-and post-harvest crop losses, inadequate research-extension- farmer linkages to increase agricultural productivity, lack of mechanised methods of production as well as high costs and adulterated farm input like fertiliser, seeds, pesticides and vaccines are some of the main challenges the Big Four Agenda is currently facing in Kenya. To achieve food security and proper nutrition for all Kenyans, the government targets to increase production of maise from 40 million 90 kg bags annually to 67 million bags by 2022; rice from around 125,000 metric tons currently to 400,000 metric tons by 2022 and potatoes from the current 1.6 million tons to about 2.5 Metric Tons by 2022. In the 2018/2019 budget, Ksh. 17.9 billion was allocated for ongoing irrigation projects countrywide with a view to transforming agriculture from subsistence to productive commercial farming (Government of Kenya, 2021).

Narok County is one of the rural counties in Kenya. The agricultural extension service plays a key role in disseminating knowledge, technologies and agricultural information and in linking farmers with other actors in the economy. Narok County is dominated by the Maasai Community, which is one of the marginalised communities in Kenya. Currently, there are 30 ward agricultural officers for the 30 wards and 6 crop officers for the 6 sub-counties (Narok County Integrated Development Plan, 2018). The rest of the extension workers are aligned towards livestock, fishing and other sectors in the county. In the recent past, there has been an entry of private extension service providers in the county (Kileteny & Wakhungu, 2019).

According to the Kenya National Bureau of Statistics (2019), Narok County has a population of 1,153,273 with a population density of 47 persons per square kilometre. Narok County is generally divided into 4 livelihood zones: mixed farming, agro-pastoral, pastoral and formal employment. More than one third (33.8%) of the population in Narok County lives under the poverty line (KIHBS 2016) even though the county is endowed with natural resources such as those found in the Maasai Mara Reserve, the Mara River and has arable land suitable for agriculture.

1.2 Statement of the Problem

Food security remains one of the main concerns for the residents of the rural areas of Narok East sub-County (Kileteny & Wakhungu, 2019). Despite the fact that significant food security initiatives in the sub-County, food insecurity and extremely rural poverty have continued to pose major socio-economic problems to many households in the sub-County to date. Over time, the Government and other development agencies have invested a large number of resources to address food security concerns through projects and programs, but minimal success has been realised. According to Kenya National Bureau of Statistics (2019), an estimated 120,000 people in rural areas and 30,000 in urban centres of Narok County remain food insecure. A good percentage of this population resides in Narok East which is drier and experiences high levels of drought throughout the year.

Generally, most studies like that of Tesfaye and Tirivayi (2018), Roy *et al*. (2012) and World Bank (2018), on food security have focused on establishing the factors that determine food security such as

technology, infrastructure and population. Some critical factors such as post-harvest technology/handling and how it determines food security in rural areas have not been a focus of most research, especially those conducted in Kenya, indicating a gap that this current study seeks to fill. This study is set to critically evaluate the extent to which post-harvest technology influences food security in Kenya with a specific focus on ASAL areas, including the Narok East sub-County.

1.3 Objective of the Study

- The main objective of this study is to assess the influence of post-harvest technology on food security in Narok East sub-county, Narok County, Kenya.

1.4 Hypothesis of the study

- HO1: There is no significant relationship between post-harvest technology and food security in Narok East sub-County, Narok County, Kenya

2. Literature Review

2.1 Post-Harvest Technology on Food Security

According to Krishnamurthy *et al.* (2013), the post-harvest framework has numerous essential procedures and exercises that can be divided into technical activities, which envelops reaping of yields, field drying, sifting, cleaning, extra drying, storage, processing and economic activities, which together include transporting, marketing, amongst other aspects. According to World Bank (2017), when there is improvement in post-harvest technology, there is a likelihood that waste being experienced due to poor handling of harvested food is minimised, making the availability, accessibility, and utilisation of the food more appropriate in certain areas.

A study on Post-Harvest Handling in Malaysia by Kabahenda *et al*. (2009) noted that the deterioration process begins as soon as a crop is extracted from the field or separated from its parent plant. Post-harvest treatment can largely determine the crop's final quality, whether it is being sold for fresh consumption or used as an ingredient in processed foods. Therefore, successful handling is necessary for a reduction in post-harvest losses, especially for farmers in developing nations. Many studies have suggested that post-harvest technology affects food production, but no extensive research links it directly to food security.

A study by Paliyath *et al.* (2019) on improving post-harvest shelf life and product quality noted that one explanation for this lack of consideration and funding might be that post-harvest systems include a wide range of activities, including product quality, harvesting and storage, use and marketing, and policy and institutions. Given the complexity of post-harvest processes, it is deemed hard to determine the entry point for research expenditure and post-harvest research impact assessment. Yet there is a growing consensus on the critical role post-harvest research can play in achieving the overall objectives of income growth, food security, poverty alleviation, and sustainable agriculture, especially in developing countries (Alexander *et al.*, 2017).

Study on 'Global Food Losses and Post-Harvest Food Waste Losses (PHL),' Smith (2013), noted that post-harvest losses are a major factor in food shortages in Eastern Africa. While PHL's volume and effect are well known, there has been little progress in mitigating them up to now. This failure is mainly due to the multitude of reasons for losses, involving multiple players at all levels of complex food systems. In addition, these actors work within sometimes insufficiently understood social, political, cultural, and environmental contexts.

In a review of the World Development Report (2011), Jones and Rodgers (2011) indicated that when actual research is carried out to determine losses instead of relying on expert opinions, the resulting figures tend to be much lower, around 5 per cent for grain. According to Kato and Greeley (2016), traditional post-harvest systems tend to be fairly efficient since poor farmers cannot afford to waste food. Most of the food is lost during and after harvesting in Africa due to poor post-harvest handling technology. World Bank (2018), further establishes that the amount of food lost each year through post-harvest losses in Africa could feed a third of her population if well-handled year in year out.

On-farm storage technology can save energy and boost farm incomes. Roy et al. (2012) noted that the green revolution has led to a massive increase in grain production in many developing countries,

especially during the wet season, when it is difficult to dry grain properly. Traditional post-harvest systems have not been designed to dry and store such large quantities, and losses following harvest have increased. Such losses can be minimised by improved processing, drying, transporting and milling methods, battling pests from storage, or making grains more resistant to moulding. FAO study in 2014 suggested that while the share of post-harvest activities in total value-added food products in developing countries appears to be lower, there is a tendency for post-harvest operations to be of greater importance (FAO, 2014).

According to Tesfaye and Tirivayi (2018), the activities of African smallholder farmers have helped to make food security possible. Agricultural products are increasingly not consumed in their raw form, and post-harvest activities such as transportation, storage, processing, and marketing account for an increasing part of their end value (FAO, 2014). Although work on improving agricultural production has received significant attention and support, post-harvest activities and international research organisations have not attracted much attention until recently. Although there is a large volume of studies on security determinations in the world, little has been recorded on the impact of post-harvest services in addressing the situation of food security in developing countries and particularly in ASAL areas like Narok County.

According to Brown (2016), food losses do not encompass losses in quantity but also in the quality of food, which may hamper edibility, making it harder for human consumption. In Africa, 30% of the harvested food gets lost through wastage, inadequate storage technology and poor harvesting techniques. Staple foods contain not only essential nutrients but also important vitamins (World Bank, 2018). Weevils feed particularly on the endosperm within the seed, which is wealthy in starch, while numerous parasites attack the cereal cover, which is rich in vitamins. Vitamin content is likewise affected by humidity during storage and by mould infection. In Africa, the rural sector has been greatly affected by inadequate or lack of technology for handling harvested food hence more wastage (FAO, 2016).

According to White (2016), one of the major issues affecting food security measures in developing countries is the post-harvest losses menace since it has led to the loss of more than one-third of what is harvested in a given time. For instance, at the farm level, farmers need to harvest their food crops on time, dry them timely and store them appropriately to avoid unnecessary losses, which in turn reduce their farm outputs (World Bank, 2018). There is a need for County Governments in Kenya to invest proper infrastructure on the farm and off-farm product handling processes, invest thoroughly in agricultural extension services, advanced processing and storage facilities and ensure that there are appropriate pest control mechanisms from the local to the national level especially in rural settings (Alexander et al., 2017).

2.2 Sustainable Livelihoods Framework

The proponents of this model are Robert Chambers in the 1980s and Conway in the 1990s, who wanted to come up with a model that can establish factors that encompass sustainability in development projects (Berger & van Helvoirt, 2018). According to this framework, development experts should act as facilitators on what people consider as their problems, cultural variations, and how a combination of these factors enables them to appreciate their environments and forms of livelihoods inherent in these settings.

Conway (1996) further asserts that for sustainable development to occur, people need to know what their priorities are, and outsiders should act as facilitators by ensuring that people are in charge of what they consider to be their main pressing needs. The result of any development discourse has to be sustainability, making people appreciate their effort and work towards improving their living standards (Conway, 1998). This approach maximises physical, social, human, natural and financial capital to ensure that sustainable livelihoods for people in a given setting have been holistically achieved. This approach has been applied in food security projects to ensure that people control resources, including post-harvest technologies for sustainable food security programmes.

The sustainable Livelihood Approach was applied to this study by establishing the extent to which post-harvest technology determines food security in Kenya generally and Narok East sub-County specifically. This approach on food security will enable the poor to foster poverty reduction

interventions by building on their own opportunities, supporting their access to assets, building resilience and coping mechanisms and developing an enabling policy and institutional environment for sustainable food security initiatives.

3. Materials and Methods

The study adopted a descriptive research design which enabled the study ***to*** gather both quantitative and qualitative analytical data. Descriptive research is defined as a method that describes the characteristics of the population or phenomenon that is being studied (Kothari, 2019). The target population is comprised of 25,078 households in Narok East Sub County (KNBS, 2019). It also targeted 5 Agricultural Extension Officers in the sub-County who were further considered for the study as they are distributed in all the four wards in Narok East sub-County. Therefore, for the key informants, this study was a census. For this study, the sample was computed using sample size formula developed by Krejcie and Morgan (1970), as shown below:

$$n = \frac{\chi^2 \times N \times P(1-P)}{\left(ME^2 \times (N-1)\right) + \left(\chi^2 \times P \times (1-P)\right)}$$

Where
n = sample size
χ^2 = chi-square for the specified confidence level at 1 degree of freedom = (3.841) from tables
N = population size
P = population proportion (0.50 in the table)

$$n = \frac{3.841 \times 25078 \times 0.5 \times 0.5}{0.05^2 \times (25078 - 1) + 3.841 \times 0.5 \times 0.5}$$

$= 24081/(63.65)$
= 378 Households

A sample for the study was selected from the households using simple random sampling method.

An ordered questionnaire was adopted for this study as the principal instrument for data collection. For the Agricultural extension workers, an interview guide was used in the study. Qualitative data was analysed through thematic analysis in order to corroborate with quantitative data. The study used the Kaiser-Meyer-Olkin Measure of sampling adequacy to test the research instrument's validity, and the overall KMO value of 0.749 was obtained. The overall reliability index for the study was 0.837. These results corroborate findings by Saunders, Lewis and Thornhill (2009) and Christensen, Johnson and Turner (2011), who stated that scales of 0.7 and above indicate satisfactory reliability**.** The questionnaire was analysed using descriptive statistics of frequencies, means and percentages. ANOVA was used to test the model's fitness to explain the connection between variables for inferential statistics. Simple linear regression was also tested for the study.

4. Results and Discussions

The researcher distributed a total of 378 questionnaires, and only 299 were returned and used for the analysis representing a 79% response rate as shown in Table 1.

Table 1: *Response Rate*

Response	**Distributed**	**Returned**	**Non-response**
Number of questionnaires	378	299	79
Percentage %	**100**	**79**	**21**

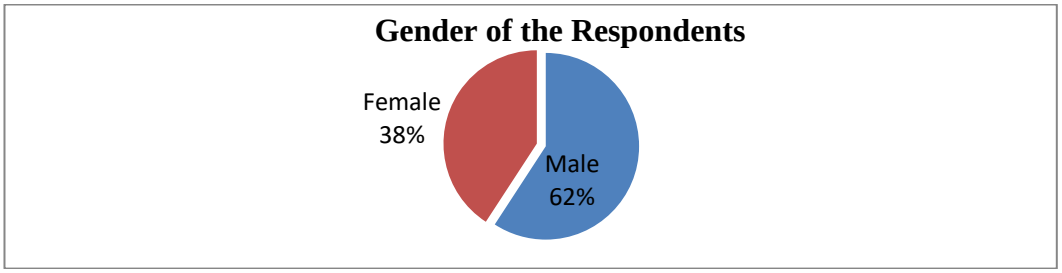

Figure 1: *Gender of respondents*

The results presented have indicated that there were more male (62%) respondents compared to 38% female. This implies that most of the households that participated were headed by males. This is true for patriarchal communities where the men are key decision-makers in the family. A similar finding was noted by Alawode et al. (2020) in their study on the effect of land use and land market on the food security status of farming households in South-Western Nigeria noted that the majority of the farmers (over 67%) who participated in the study were male.

Table 2: *Respondent' Education Level*

Levels	Frequency	Per cent
None	68	22.7
Primary school	56	18.7
Secondary school	46	15.4
College/Diploma level	47	15.7
University/Degree level	82	27.4
Total	**299**	**100.0**

From the results presented in table 2, it is shown that 27.8% of the respondents had attained University /degree level of education, 22.7 % had not attained any formal education, and 18.7% had only attained primary education, while 15.7% and 15.4% had attained secondary school level and college/diploma respectively. This implies that most farmers had basic education, which they use to make the appropriate decision in their farming activities. Alawode, Olaniran and Abegunde (2020) also established the same where they noted that most farmers who have no good formal education could contribute to the low productivity and hence food insecurity in many developing nations.

Table 3: *Average Size of Households*

Size of household	Frequency	Per cent
1 person	16	5.4
2-4 people	46	15.4
5-7 people	81	27.1
8-10 people	109	36.5
Above 10 people	47	15.7
Total	**299**	**100.0**

From the results, it is noted that 36.5% of the household in the sub-County had an average of 8-10 persons followed by 27.1% who had an average of 5-7 persons, 15.7% had an average of above 10 persons, while 15.4% had an average of 2-4 persons. This shows that most households were large and hence their demand for food was relatively higher, a fact that could compromise food security in the area.

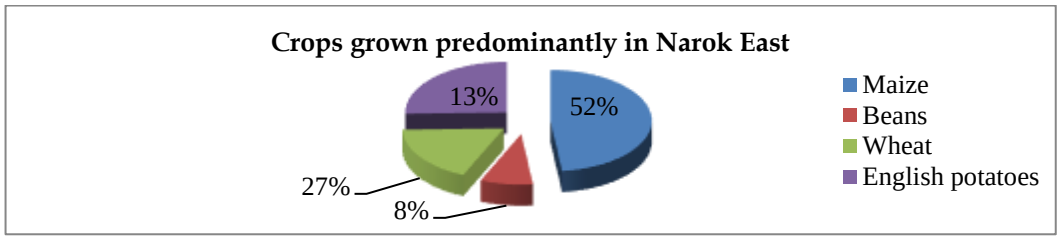

Figure 2: *Response on types of crops grown in the area*

The results show that most households (52 %) are involved in the growing of maise, followed by 27% who grow wheat. The study further establishes that 13% grow English potatoes, and only 8 % grow beans. The results indicated that most farmers grow maise and wheat, which are long duration crops and might affect the food security in the area.

Table 4: Response on Land Ownership

Land Ownership Titles	Frequency	Per cent
Legal ownership	51	17.1
Inherited land	157	52.5
Lease	38	12.7
Communal	53	17.7
Total	**299**	**100.0**

The results in table 4 show that most (52.5%) of the respondents indicated that the land they possess was inherited, 17.7% indicated that they had communally owned land, 17.1 per cent show that land was legally owned, while only 12.7% indicated that the land was leased. Land ownership has an implication on the level of development one can be able to undertake on the land, and this might have an influence on the food security in the area.

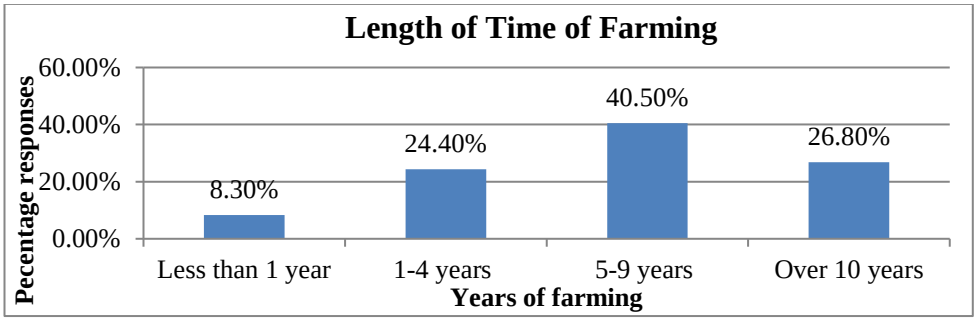

Figure 3: *Years of Farming*

The results show that majority of the respondents (40.47%) have been undertaking farming for between 5-9 years, followed by 26.76%, who have been in farming for over 10 years and 24.4%, who have been in farming for between 1-4 years. The result shows that most of the respondents have been in farming activities for more than 5 years. This implies that they have accumulated experience and understand how farming activities influence food production and hence food security in the area.

Table 5: *Response on the Level of Income*

Income level	Frequency	Percent
Below 10,000	22	7.4
10,001-20,000	31	10.4
20,001-30,000	69	23.1
30,001-40,000	108	36.1
Above 40,001	69	23.1
Total	**299**	**100.0**

The results show that the majority of the respondents (36.1%) earned between Ksh 30,000 to 40,000, 23.1 % earned between Kshs 20,000 and 30,000, while another 23.1% earned above Kshs 40,000. Only a few 10.4% and 7.4% earned between Kshs 10,000 and 20,000 and below Kshs 10,000 respectively. This implies that most households have an average income that might not be enough to support their farming activities. The results agree with the findings of Chen and Ravallion (2008), who noted that over 1.4 billion people in the world live on less than the US $1 a day which is the international poverty line. This was considered as a major contributing factor to the level of food insecurity in the developing countries, as suggested by FAO (2010).

4.1 Extent to which Post-Harvest Technology Determines Food Security

The fourth objective of the study sought to establish the extent to which Post-harvest technology determines food security in Narok East Sub County. The respondents were required to give their opinion by indicating the extent to which they agreed or disagreed with the various statements. The study results were analysed descriptively using percentages, means and standard deviations to make deductions on how the respondents gave their opinions to various statement items describing the extent to which post-harvest technology determines food security in the sub-county. The results are presented in Table 6.

***Table 6**: Extent to which Post-harvest Technology Determines Food Security*

Statement	SD	D	NS	A	SA	M	S. D
Farmers have packaging and processing technology in Narok East Sub-county	0	2.7%	4.7%	50.8%	41.8%	4.32	.687
Storage facilities have been put in place to counter post-harvest losses in Narok East Sub-county	1.7%	24.7%	35.8%	18.4%	19.4%	3.29	1.093
There is training on the importance of post-harvest methods in Narok East Sub-county	1.7%	2.3%	0	17.4%	78.6%	4.69	.747
Most farmers use traditional post-harvest methods in Narok East Sub-county	0	1.7%	5.0%	34.4%	58.9%	4.51	.672
Effective and efficient transport systems is important for enhancing food security in Narok east sub county	0	12.0%	2.7%	20.4%	64.9%	4.38	1.008
Post-harvest technology used by farmers determines food security in Narok East Sub-county	1.7%	24.7%	35.8%	18.4%	19.4%	3.29	1.093

The results show that most of the respondents (50.8%) agreed, and 41.8% strongly agreed, while only 2.7 % disagreed and 4.7% were not sure with the statement that farmers have packaging and processing technology in Narok East Sub- County. The results were further analysed using mean, and the standard deviation within which a mean of 4.32 and a standard deviation of 0.687 indicated that most respondents agreed with the statement. This means that farmers have packaging and processing facilities to enhance their post-harvest technology. However, the same farmers further noted that even though such facilities are available in the household, they can only handle limited storage and cannot be relied upon for a long period of time.

The results from the interview indicated that there are no County storage facilities (Cereals board) in Narok East, so farmers are forced to rely on the cereals board in Narok town. Extension workers further indicated that farmers had been sensitised to the use of the hematic bags for the storage of the cereals to reduce the post-harvest damages. According to extension workers, each hematic bag costs Ksh 250; hence few farmers can afford them. This implies that though farmers indicated having packaging and processing technology, they were still food insecure because they ended up selling their produce for fear that weevils would destroy them. This has exacerbated the issue of food security in the area.

The results further established that 35.8% of respondents and 24.7% were unsure and disagreed that storage mechanisms have been put in place to counter post-harvest losses in Narok East Sub-County. Only 19.4% and 18.4% strongly agreed and agreed, respectively, with the statement. The study further established that 1.7% of the respondents strongly disagreed that storage mechanisms have been put in place to counter post-harvest losses in Narok East Sub-county. The study also established that a mean response of 3.29 and a standard deviation of 1.093 indicated that most respondents disagreed with the statement. This implies that there are no proper storage mechanisms in place in the county to help in solving the post-harvest losses.

The results also show that the majority of the respondents (78.6%) strongly agreed, and 17.4% agreed with the statement that farmers go through training on the importance of post-harvest methods in the study area. Only 2.3% disagreed, and 1.7% strongly disagreed with the statement. The results further show that the majority of the respondents indicated a mean of 4.69 and a standard deviation of .747 shows that there is training on the importance of post-harvest methods in the sub-county. Therefore

most respondents agree that even though there is training, food insecurity in the sub-county is still rampant because how farmers can realise the gains of the training provided by extension officers cannot fully be established.

Most of the respondents (58.9%) strongly agreed, while 34.4% agreed that most farmers use traditional post-harvest methods in Narok East Sub-County. Only 1.7 % and 5.7% disagreed and were unsure whether most farmers use traditional post-harvest methods in Narok East Sub-County. This shows that the average mean response was 4.51 and a standard deviation of 0.671 further reveals that the majority of the respondents were quite aware that the farmers were using traditional post-harvest methods to improve on their storage and hence determining food security in the study area.

The results show that 64.9 % of the respondents strongly agreed, while 20.4% agreed with the statement that effective and efficient transport systems enhance food security in the study area. Only 12% disagreed even though effective and efficient transport systems are important for enhancing food security in Narok east Sub-County, there was no effective transport system in the study area to enhance food security. The mean response was 4.51, with a standard deviation of 0.672 further reveals that the majority of respondents agreed with the statement. Even though the majority of respondents agree with the above statement, they further established that there were no proper transport systems to enhance the post-harvest process to boost food security in the sub-county. This was also confirmed by the response from the interview where extension officers indicated that;

> *"Without an efficient and effective transportation system, farmers cannot be in any position to preserve their foodstuff or transport them to the market at the right time while maintaining their quality. Most farmers don't have access to the market or nearest storage facilities in the county due to the poor state of the roads. This makes it very expensive for the farmers to move their products, and hence they are forced to sell it to middlemen for fear that it will perish before getting to the market."*

On whether post-harvest technology used by farmers determines food security in Narok East Sub-County, the results show that 18.4% of the respondents agreed, 19.4% strongly agreed, while 24.7% disagreed, and 35.8% were not sure of the statement. The mean response was 3.29 with a standard deviation of 1.093, implying that the majority of the respondents agreed with the statement, which implies that the post-harvest technologies used by the farmers have an influence on food security in the sub-county.

These findings are consistent with the findings by Kabahenda *et al*. (2009), who noted that effective post-harvest practices such as effective transportation systems reduce the losses and significantly improve the availability of food, hence food security. This further agrees with Chege's (2020) finding, which established that post-harvest food losses were among the greatest challenges facing food security in Africa. This directly impacts the lives of millions of smallholder farming families every year. The researcher further noted that despite efforts globally trying to find solutions to the global food crisis, the answer does not just simply require an expansion of agricultural production. But there is an urgent need to establish sustainable solutions to the threat of global food preservation strategies to reduce food losses.

Similarly, FAO (2011) and WHO (2018) established that global food production, supply and consumption systems are not functioning to optimal efficiency, with food losses in sub-Saharan Africa alone exceeding 30 % of total crop production and representing more than US$4 billion in value every year. The results were further complemented by the Kenyan case where a report by the Republic of Kenya (2007) on 'Kenya Vision 2030: A competitive and Prosperous Nation' further indicated that Kenya losses billions of shillings every year due to post-harvest losses of all types of farm produce. WHO (2018) estimates that the loss is currently between 30– 40 %, translating to 50 million bags valued at 30 billion shillings lost every year. Chege (2020), further establishes that out of 93% of the farm produce harvested in Kenya, nearly 60% goes to waste. Therefore, this study calls for efficient post-harvest handling, storage, and marketing, which can tremendously contribute to rural communities' social and economic development in Kenya as stipulated in Vision 2030.

Table 7: *Response on the Indicators of Food Security*

Statement	SD	D	NS	A	SA	M	S. D
Food availability has determined food security at household level in Narok East Sub-county	1.7%	2.3%	7.7%	14.7%	73.6%	4.56	.862
Food utilization determines food security at house hold level in Narok East Sub-county	0	12.7%	1.0%	23.1%	63.2%	4.37	1.009
Food security is determined by food access at household level in Narok East Sub-county	5.7%	4.0%	17.1%	13.4%	59.9%	4.18	1.189
Households have access to food whenever they need it in Narok East Sub-county	6.4%	12.7%	2.0%	11.0%	67.9%	4.21	1.319
Food is utilized by farmers to meet their dietary needs at household level in Narok East Sub-county	0	6.4%	7.0%	23.7%	62.9%	4.43	.877

The results in table 7 indicate that majority of the respondents (73.6%) strongly agreed, 14.7% agreed, while 1.7% and 2.3% strongly disagreed and disagreed that food availability determines food security at the household level in Narok East Sub-County. Further analysis, however, revealed that 7.7% of the respondents were not sure as to whether food availability determines food security at the household level in Narok East Sub-County. The mean response was 4.56, with a standard deviation of 0.862 confirming this statement. This implies that the availability of food was a determinant of food security in Narok East Sub County. Most household heads are of the opinion that when food is available in the household, food insecurity dwindles to the greatest extent.

The study also sought to find out whether food utilisation determines food security at the household level in the study area. The results show that most of the respondents (63.2%) strongly agreed, 23.1% agreed, while 12.7% disagreed that indeed food utilisation determines food security at the household level in the study area. However, 1% of the respondents still were not sure as to whether food utilisation determines food security at the household level in the study area or not. The mean response of 4.35 with a standard deviation of 1.009 implied that food utilisation is a determinant of food security in the sub-County. This means that if the available food is well utilised at the household level, it will generally influence food security in the Narok East Sub-County.

The results also show that most of the respondents (59.9%) strongly agreed, while 13.4% agreed that Food security is determined by food access at the household level in Narok East Sub-County. Only 4% and 5.7% of the respondents disagreed and strongly disagreed with the statement food security is determined by food access at the household level in Narok East Sub-County. However, 17.1 per cent of the respondents were not sure as to whether food security is determined by food access at the household level in Narok East Sub-County. The mean response was 4.21 with a standard deviation of 1.189 confirms that the majority of the respondents agreed with the statement, but still a good number of respondents still are of a different opinion. This implies that food security is determined by food access at the household level in the study area if all other factors are held constant.

It was also noted that most of the respondents (67.9%) and 11 % strongly agreed and agreed with the statement that household's access to food whenever they need it. Further analysis indicated that 12.7% and 6.4% of the respondents strongly disagreed and disagreed with the statement that household's access to food whenever they need it indicates food security in the area. However, 2 % of the respondents were not sure whether households access food whenever they need it. The mean of 4.43 and a standard deviation of 1.319 confirm this argument. This implies that access to food by households in Narok east Sub County depicts a certain level of food security. However, the extension workers further revealed that the majority of the households generally have no access to food. Further analyses from interviews reveal that most households in Narok East Sub-county are generally food insecure since access to food has been hampered by other factors like inadequate roads and the purchasing power of residents.

Furthermore, the study sought to examine whether farmers utilise food to meet their dietary needs at the household level in Narok East Sub-County. The findings of the study indicated that 62.9% of the respondents strongly agreed, and 23.7% agreed with the statement above. Further analysis indicated

that 7% of the respondents were not sure of whether farmers utilised food to meet their dietary needs in the study area. The study further established that 6.4 % of the respondents disagreed with the statement above. This was further supported with a mean of 4.43 and a standard deviation of 0.877, which shows that majority of the respondents agreed with the statement above.

Table 8: *Pearson Correlation analysis between Post-Harvest Technology and Food Security*

		Food security
Post-harvest technology	Pearson Correlation	.606**
	Sig. (2-tailed)	.000
	N	299

The hypothesis of the study stated that *there is no significant relationship between Post-harvest technology and food security in Narok East sub-County, Narok County*. The F-statistic was computed and presented in table 9 below.

Table 9: *ANOVA on the Relationship between Post-Harvest Technology and Food Security*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	74.623	1	74.623	172.602	.000[b]
	Residual	128.405	297	.432		
	Total	203.027	298			

The results show that the F-statistic was very significant at 5% level of significance, implying that the model is a good predictor of the change in the dependent variable. The results are shown in Table 4.8. The study also establishes the model fitness by comparing the F- calculated and F-critical values. The results for F-calculated were $F_{0.05,\,1,\,297}$ =172.602 compared to the F-Critical, $F_{0.05,1,\,297,}$ which was 3.873. Since F-calculated is greater than F-Critical at $F_{0.05,\,1,\,297,}$ the study concluded that the model is a good predictor of the relationship between the dependent and independent variables. This is further supported by a p-value of 0.000, which is very significant at 5% level of significance. Therefore, the null hypothesis is rejected, implying that post-harvest technology is a determinant of food security in the study area**.**

Table 10: *Simple Linear Regression analysis*

Independent variable	**R**	**R^2**	**Adjusted R^2**	**Std. Error of the Estimate**	**P-value**
Post-harvest technology	.606[a]	.368	.365	.658	.000[b]

4.2 Dependent variable: Food Security

From the results, the value of R denotes the correlation between the independent and the dependent variables. For post-harvest technology and food security, the study establishes a strong positive correlation that is very significant (R = 0.606; p-value = 0.000). Post-harvest technology was established to be a very strong predictor of food security in the study area.

Further analysis was done using the $R^{2,}$ which indicates the proportion of variance in the dependent variable that can be explained by a unit change in the independent variable. The results show that a unit change in post-harvest technology can explain a 36.8 % change in food security (R^2 = 0.368). This implies that post-harvest technology is a significant determinant of food security in the Narok East Sub-County. The adjusted r- square is used to estimate the population R square for the model and gives a more realistic indication of its predictive power.

5. Summary of the Findings

5.1 Demographic variables

The response rate was 79% which was accepted as appropriate for further analysis of the study results. The results were in tandem with Marton (2006), who noted that a response rate of above 70% is considered appropriate for a descriptive study. Regarding the gender of the respondents, the study established that 62% of the households were headed by males, which implied that men were the main

decision-makers in the household unit in the study area. In regard to the level of education, which was an important aspect of the study, it was established that there were varying levels of education where some had degrees while others had basic education. The study further assessed the size of the household as a factor determining food security in the study area. It was established that most households (36.5%) had an average of 8-10 persons. It was also important to establish the type of crops grown in the study area. The results indicated that most households (52%) in the study area are involved in maise production. On land ownership, the study established that most respondents (52.5%) indicated that the land was mainly inherited or communally owned, which might be a contributing factor to the state of food security in the study area.

It was also explored that the size of land under crop cultivation was at least 5 acres in comparison to the actual size of the land. This implies that most households had committed a small proportion for food production hence contributing to the food security issues in the study area. The study further established that most of the respondents had been in the farming practice for between 5-9 years; hence it implies that they have accumulated experience and understand how the farming activities determine food production and hence food security in the area. The study also established that at least 36.1% of the respondents earned between Ksh 30,000 to 40,000, indicating an average income that was not enough to sustain increased demand for food production in the study area.

5.2 Extent to which Post-Harvest Technology Determines Food Security

The objective of the study sought to establish the extent to which Post-harvest technology determines food security in Narok East sub-County. The respondents were required to give their opinion by indicating the extent to which they agreed or disagreed with the various statements provided in the questionnaire. The study established that the majority of the respondents agreed that farmers have packaging and processing technology in the Narok East Sub-county. However, it was noted that despite these farmers having these storage facilities at the household level, they can only handle limited storage and cannot be relied upon for a long period of time since they do not have the means to preserve the produce that long. Farmers were still food insecure despite having appropriate storage facilities in the household. The sub-County has not provided any food storage facility. Most farmers only relied on what Narok North sub-County provided, which still has no capacity to handle food in large quantities. This has exacerbated the issue of food insecurity in the study area since middlemen took advantage of the agonies of farmers by procuring their produce at a throw-away price. The results further established that most farmers disagreed that storage mechanisms have been put in place to counter post-harvest losses in the Narok East sub-county. This implies that there are no proper storage mechanisms in place in the sub-County to help in solving the post-harvest losses.

The majority of the respondents also agreed that farmers go through training on the importance of post-harvest methods in the study area. However, they noted that the training is never effective because they lack the appropriate income to implement the procedures learnt from extension workers. Farmers also indicated that they lacked effective and efficient transport systems to enhance transportation of their products before they were spoiled hence incurring high losses hence food insecurity in Narok East sub-County. This shows that post-harvest technology has an influence on food security in the area since it minimises losses to the greatest extent. These findings are consistent with the findings by Kabahenda *et al.* (2009), WHO (2018) and FAO (2011), who established that global food production, supply and consumption systems are not functioning to optimal efficiency hence promoting a high level of food losses. The results further indicated that there is a strong positive and significant correlation between post-harvest technology and food security in the sub-County. This shows that insecurity can be mitigated to the greatest extent if post-harvest losses are put in place in order to curb post-harvest losses. The hypothesis that there is no significant relationship between Post-harvest technology and food security in Narok East sub-County, Narok County was rejected, implying that post-harvest technology is a determinant of food security in the study area**.** The results further indicated that post-harvest technology had a very strong significant relationship with food security, meaning that it positively impacts the improvement of food security in Narok East sub-County, Kenya.

6. Conclusions and Recommendations for the study

The main objective of this study was to analyse the influence of post-harvest technology on household food security in Narok East sub-County, Kenya. The findings of the study revealed that most of the

households in the Narok East sub-County were food insecure. Additionally, the study concluded that there is a very strong positive and significant relationship between post-harvest techniques and household food security in Narok East sub-County. Post-harvest technology was established to have the highest influence on food security because it was noted that the sub-County did not have adequate post-harvest handling facilities and infrastructure. Therefore, the study area is marred with post-harvest losses; hence the study indicated it as a major cause of food insecurity amongst residents. This implies that for Narok East sub-County and the entire Narok County to be food secure, there is a need for the County government in collaboration with other stakeholders to ensure that first, farmers have access to post-harvest processes of handling farm produce by training the farmers on new techniques of food preservation and also making it possible for them to access the market as fast as possible in order to mitigate post-harvest losses.

The study further provided key recommendations as follows;

i. First, the County government should establish alliances/collaboration with all agricultural sectors to develop programs for improving food security among the households to boost the income of farmers at the micro-level.

ii. Secondly, there is a need to develop a rural agricultural extension service strategy to enhance issues beyond those of production and access to food, thereby requiring linkages and collaborative efforts with other organisations, both public and private.

iii. Thirdly, the study recommends that the County government build a platform to promote dialogue and cooperation among relevant institutions and establish programs in all sectors to develop an extension and information services network for households in Narok County particularly.

iv. The County government should formulate a reasonable crop production system necessary to improve land-use efficiency. Therefore, there is a need to improve the agricultural sector by using suitable crop strains, developing technology and implementing a reasonable strategy.

v. Additionally, research and development need to be promoted and supported by the Narok County government to ensure continued research and dissemination of research findings to the household level to benefit farmers.

Acknowledgement

My sincere appreciation goes to Jomo Kenyatta University of Agriculture and Technology and Maasai Mara University for giving me support and guidance during the whole research process. I would further like to thank the Narok East Community and agricultural heads for their support during the data collection period.

References

Alawode, O. O. (2013). Determinants of land-use conflicts among farmers in South-Western Nigeria. *Journal of Research in Peace, Gender and Development*, *3*(4),58-67. https://www.researchgate.net/publication/327537126

Alawode, O. O., Olaniran, O. M., & Abegunde, V. O. (2020). Effect of land use and land market on food security status of farming households in South-Western Nigeria: Evidence from Oyo State. In *Selected Paper for presentation at the Feed Future Nigeria Agricultural Policy Project Conference, Abuja, Nigeria*.https://www.researchgate.net/publication/327537126_Effect_of_Land_Use_and_Land_Market_on_Food_Security_Status_of_Farming_Households_in_South-Western

Alexander, P., Brown, C., Arneth, A., Finnigan, J., Moran, D., and Rounsevell, M. D. (2017). Losses, inefficiencies and waste in the global food system. *Agricultural systems*, *153*, 190-200. https://www.sciencedirect.com/science/article/pii/S0308521X16302384

Béné, C. (2020). Resilience of local food systems and links to food security–A review of some important concepts in the context of COVID-19 and other shocks. *Food Security*, 1-18. https://link.springer.com/article/10.1007/s12571-020-01076-1

Brown, M. E. (2016). Remote sensing technology and land use analysis in food security assessment. *Journal of Land Use Science, 11*(6), 623-641. https://doi.org/10.1080/1747423X.2016.1195455

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: practical concepts for the 21st century*. Institute of Development Studies (UK). https://www.ids.ac.uk/publications/sustainable-rural-livelihoods-practical-concepts-for-the-21st-century/

Chege, J. (2020). *Role of Bio fortified Crops in Mitigating Food Security in the Rural Households in Murang'a County: A Case of Women Farmers of Dry Land Arrowroots* (Doctoral dissertation, University of Nairobi).

Chen, S., & Ravallion, M. (2008). The developing world is poorer than we thought but no less successful in the fight against poverty. *World Bank Policy Research Working Paper* 4703.

Conway, J. H., & Guy, R. (1998). *The book of numbers*. Springer Science & Business Media. https://books.google.com.bn/books?id=rfLSBwAAQBAJ

Conway, M. A. (1996). Autobiographical knowledge and autobiographical memories. https://books.google.com.bn/books?id=rfLSBwAAQBAJ

FAO. (2010). Food and Agriculture Organization of the United Nations. *Retrieved,* 3(13), 2012.

Gartland, K. M., & Gartland, J. S. (2018). Contributions of biotechnology to meeting future food and environmental security needs. EuroBiotech J, 2(1), 1-9. https://doi.org/10.2478/ebtj-2018-0002

Gwada, R. O., Ouko, K. O., Mayaka, Z. O., & Dembele, B. (2020). Determinants of Food Security among Small-Scale Soybean Households in Butere Sub-County, Kenya. *Contemporary Agriculture*, *69*(3-4), 90-101. https://doi.org/10.2478/contagri-2020-0012

Government of Kenya. (2021). *Kenya and Food Security*. Nairobi, Kenya.

Harrigan, J. (2014). An Economic Analysis of National Food Sovereignty Policies in the Middle East: The Case of Lebanon and Jordan. In: Babar, Z. and Mirgani, S., (eds.), *Food Security in the Middle East*. Hurst and Oxford University Press.

Jones, G. A., & Rodgers, D. (2011). The World Bank's World Development Report 2011 on conflict, security and development: a critique through five vignettes. *Journal of International Development*, *23*(7), 980-995. https://doi.org/10.1002/jid.1826

Kabahenda, M. K., Omony, P., & Hüsken, S. M. C. (2009). Post-harvest handling of low-value fish products and threats to nutritional quality: a review of practices in the Lake Victoria region. Nairobi. Kenya. https://hdl.handle.net/20.500.12348/1463

Kato, T., & Greeley, M. (2016). Agricultural input subsidies in sub-Saharan Africa. *IDS Bulletin, 47*(2), 33-48. https://doi.org/10.19088/1968-2016.130

Kenya Agricultural Research Institute. (2020). *Kenya Vision 2030: A competitive and Prosperous Nation.* Government Press.

Kenya National Bureau of Statistics (2019). *Kenyan Census*. https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county

Kileteny, T., & Wakhungu, J. W. (2019). Influence of Livelihoods on Household Food Security in Pastoral Areas of Narok County, Kenya. *International Journal of Research - Granthaalayah*, *7*(9), 351–381. https://doi.org/10.29121/granthaalayah.v7.i9.2019.618

Kivisi, F. S. (2019). Japan-Kenya Relationship, the Human Security Concept and Kenya's Big FourAgenda. *American Journal of Public Policy and Administration*, *4*(1), 48-64. https://doi.org/10.47672/ajppa.388

Kothari C.R. (2019). *Research Methodology. Methods and Techniques*. New Age International Limited.

Krishnamurthy, P. K., Hobbs, C., Matthiasen, A., Hollema, S. R., Choularton, R. J., Pahari, K., & Kawabata, M. (2013). Climate risk and food security in Nepal analysis of climate impacts on food security and livelihoods. *Development Policy Review, 60*(3), 200-231. https://hdl.handle.net/10568/34077

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

M'Kaibi, F. K., Steyn, N. P., Ochola, S. A., & Du Plessis, L. (2017). The relationship between agricultural biodiversity, dietary diversity, household food security, and stunting of children in rural Kenya. *Food science & nutrition, 5*(2), 243-254.

Marton, C. L. (2006). Improvement of maise chilling tolerance by breeding. In *enhancing the use of crop genetic diversity to manage abiotic stress in agricultural production systems. Proceedings of a*

workshop, Budapest, Hungary, 23-27 May, 2005 (pp. 63-67). International Plant Genetic Resources Institute (IPGRI).

Millennium Summit. (2000). *Food security and sustainable development in Southern Africa* (Vol. 6). HSRC Press.

Narok County Integrated Development Plan. (2018). *Development blue print (2018-2022),* Narok County.

Paliyath, G., Murr, D. P., Handa, A. K., & Lurie, S. (2019). *Post-harvest biology and technology of fruits, vegetables, and flowers*. John Wiley & Sons.

Poulton, C., & Kanyinga, K. (2014). The politics of revitalising agriculture in Kenya. *Development Policy Review*, *32*(s2), s151-s172. https://doi.org/10.1111/dpr.12080

Roy, Kreider, P., Pepper, J., & Roy, M. (2012). *Identifying the Effect of WIC on Very Low Food Security among Infants and Children.* University of Kentucky Centre for Poverty Research. http://www.ukcpr.org/Publications/DP2012-11.pdf.

Saunders, M.L Lewis V. & Thorn hill, W., (2009). New paradigm in understanding food security in Bangladesh: experiences from fieldworks in coastal areas of southwest Bangladesh. *Review of Applied Socio-Economic Research*, *14*(2), 74-90.

Smith, P. (2013). Delivering food security without increasing pressure on land. *Global Food Security, 2*(1), 18-23. https://doi.org/10.1016/j.gfs.2012.11.008

Tesfaye, W., & Tirivayi, N. (2018). The impacts of post-harvest storage innovations on food security and welfare in Ethiopia. *Food Policy*, *75*, 52-67. https://doi.org/10.1016/j.foodpol.2018.01.004

Gartland, K. M., & Gartland, J. S. (2018). Contributions of biotechnology to meeting future food and environmental security needs. *EuroBiotech J, 2*(1), 1-9. https://doi.org/10.2478/ebtj-2018-0002

World Health Organization. (2018). *The state of food security and nutrition in the world 2018: building climate resilience for food security and nutrition.* Food & Agriculture Org.

White, S. C., (2016). Beyond the grumpy rich man and the happy peasant: Mixed methods and the impact of food security on subjective dimensions of wellbeing in India. *Oxford Development Studies*, *44*(3), 332-348. https://doi.org/10.1080/13600818.2015.1120278

World Bank. (2018). *World Bank Annual Report 2018*. The World Bank.

World Development Report. (2011). *Food Security and Conflict.* Agriculture and Rural Development Department, World Bank.

World Food Summit. (1996). In *World Food Security* (pp. 347-360). Palgrave Macmillan.