

Research Article

Irish Potato Production and Consumption Amid Climate Change and Variability Among Small Scale Farmers in Narok South Sub- County-Kenya

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Abstract

This study explored on Irish potato production and consumption among small scale farmers amid climate change and variability in Narok south sub- county-Kenya. The study employed focus group discussions and cross sectional descriptive survey research methods for data collection. A total of 393 small scale farmers were randomly sampled through multistage sampling procedure for descriptive survey and controlled focus groups discussion. Data from the cross section survey was screened and analysed using Statistical Package for Social Sciences version 22.0 program to give frequencies and percentages. Chi-square was calculated and inference made at confidence level of $\alpha=0.05$. focus groups discussion was analysed qualitatively. The results indicated that, majority (71.5%) of the respondents got their Irish potato seeds for planting from previous harvest. Handsomely 64.1% of the respondents responded by indicating that they planted other crops when they lacked Irish potato seeds. The study further indicated that, significant 92.9% of farmers were not taking on any an initiative on value addition method which could enhance their money in their pockets. Majority (76.9%) didn't know how to make French fries in their homes nor sell it to their neighbours. The study moreover, indicated that a sizeable (35.3%) of the respondents consume Irish potato as an accompaniment to other foods. Further, about 33.2% of the respondents indicated that, they consume Irish potato as main dish. The study also highlighted that 82.3% of the respondents highly observed pest and disease as Irish potato production challenges amid climate change and variability. The study concluded that climate change and variability has influence on Irish potato production and consumption and therefore affecting food security and availability in Narok County. This study therefore recommends that; the agricultural extension agents should endeavour to train farmers on positive potato seed selection or similarly direct farmers where they can get certified quality Irish potato seeds.

Keywords

Consumption, Utilisation, Value Addition, Small Scale Farmer, Food Security, Ware Potato

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1. Introduction

According to [1] the nexus of agricultural production, Nutritional availability, health status, and income generation came into limelight lately. Across the globe about one billion people worldwide generally suffer from food insecurity. It's marked that, the main food nutrients which are vitamin and mineral are deficit in food. This put billions of people at compromising health status. It also noted that more than two billion people still face food insecurity intermittently due to varying notch of poverty [51]. According to International Livestock Research Institution [24] Agriculture is the primary source of calories and essential nutrients and is presently a major source of income for eighty percent of the world's poor.

For sound and healthy life, adequate and appropriate nutrients need to be incorporated in food production [12]. Presence of poor diets, disease, and other factors mean that many people do not get the adequate and appropriate nutrients they need for a sound and healthy life. Moreover, hunger and malnutrition have long lasting effects throughout the life cycle, since undernourished offspring grow up to be less vigorous and prolific than they are actually supposed to be [4, 5].

For this reason, the need for new alternatives for a sustainable agricultural production and consumption options of Irish potato in mass will provide a practical solution to alleviate the problems of malnutrition problems as potato serves as a vital source of calories, vitamins, proteins, potassium and fibre [17, 39]. A more reliable harvest could give farmers the confidence to invest on improved techniques that could further boost their yields and nutrition status as they evade the consequences of persistent drought which is brought by climate change [8, 15, 46].

The International Food Policy Research Institute [23] tries to analyse the amount of calorie availability by 2050 with and without climate change. After analyses the institute predicted that calorie intake will decline and this will add an additional 24 million undernourished children who are within 0-5 years, this is 21% much more compared with the world without climate change. Half of this population would be living in sub-Saharan African Nations.

Similarly, [49] analysed the study which was steered in Ethiopia to predict three food requirement and consumption scenarios by 2050. The first scenario was purely based on situation where there was assumed there was no climate change and have normal population growth. Under this scenario they indicated that there will be food requirement and consumption of 2322 and 2160 kcal per capita per day respectively. The second scenario was also based on normal population growth with climate change. The scenario indicated that there will be food requirement and consumption of 2296 and 1788 kcal per capita per day respectively. The third scenario was based on low population growth with climate change. The scenario indicated that there will be food requirement and consumption of 2322 and 2192 kcal per capita per day respectively [45].

1.1. Irish Potato Harvesting, Sorting and Transport to the Market

According to [33, 50] harvesting and marketing of Irish potato is critical stage on Irish potato farming and thus requires skilled labour. Harvesting of Irish potato in Africa at small scale level is done manually using hoes [43, 44]. This means if done by those people who are not experienced it can seriously lead to damage of the most wares compromising the quality. This damaged wares are finally left with a farmer forming a loss on his part [40, 53].

After harvesting the farmers takes the first step by removing dirt (soil) from ware potatoes [6, 48]. This is followed by sorting into various sizes. Those bigger in sizes are bulked together and are meant for large market. Medium sizes are also bulked together and are meant for, nearby market while small ones are bulked together and meant within the villages. These small ones are also stored for next season and stored as seeds [29, 41, 42].

Transport of Irish potato from farm to the market place is very important factor the farmer considers since failure to handle Irish potato properly can also lead to loss of farmers produce [9, 27]. Farmers are advised to use sisal twine bags so as to provide aeration of wares. This is because air tight bags lead to rotting of ware potato very quickly [18, 25, 42, 48].

1.2. Irish Potato Consumption

In Kenya, according to [13] Irish potato consumption statistics trend shows that, in 1990 consumption per capita per year was 26.93kg which rose to 34.43kg in the year 1991 and significantly dropped to 20.20 in the year 1993. Consumption per capital per year dropped significantly on the year 2000 where consumption was 16.15 kg. The highest consumption of Irish potato was noted on the year 2005 with 63.62kg. From this back ground information consumption of Irish potato is so far below than expected [47]. This decline of consumption is attributed to low production and consumption value addition options [20, 34, 48].

Although improving potato production has proved to be a difficult challenge for plant breeders due to occasional change of weather [7]. In Kenya, Irish potato production and consumption have been noted that, it has high nutritive value and has many value chain benefits including animal feeds [11, 14]. Therefore, consumption of it could fill the gap of food insecurity within the country and at small scale household levels [11, 28]. [30] on his research noted that many farmers do not understand the nutritional value and value chains attached to Irish potato production and their benefits. If policy makers, researchers, agricultural extension and farmers at large can be able to give merit where it's due, Irish potato production can be solely adopted to curb poverty, famine and malnutrition. [31, 39] on the other hand indicated that, in most African communities' if they embrace Irish potato consumption, it

could be very important milestone in curbing hunger since its value chains products can be stored for longer period and thus they could provide nutritive values during periods of drought.

At small scale households' levels, Irish Potato consumption according to [38] is relatively low due to less knowledgeable on the numerous chances and recipes for adding value and product divergence for household utilization. [32, 39] Irish Potato can produce several value added recipes which could lead to provision of numerous vitamins and minerals as well as phytochemicals including carotenoids and polyphenols. In fact, [28] shows that 150g potato (medium size) when boiled with its skin provides 27mg of vitamin C (45% of the total human daily value), 620mg of potassium (18% of total human daily value), 0.2mg vitamin B6 (10% of human daily value) and trace amounts of, riboflavin, folate, thiamine, magnesium, niacin, zinc, iron, and phosphorus.

Moreover, [28] adds that, the skin of Irish potato (2g) contains fibre corresponding to that of many whole grain pastas, breads as well as cereals. Nutritional wise, Irish potato contains carbohydrate content of approximately 26 g in a 150 g medium potato. Most small scale households usually use

and utilise traditional Irish potato recipe which is boiling and stewing. This traditional recipe appears to be less appealing to both youth and children [26] Further to this, boiling and stewing does not easily and quickly break down the starch in potato and therefore digestive enzymes allows it to travel and be flushed out from digestive system. Some recipe allows the starch in potato to travel up to colon/large intestines where it is broken down to provides starch for gut microorganisms and thus boosting the health status of digestive system [22, 26]. For this reason, promotion of Irish potato production and consuming it in various value added product technologies will have numerous advantages both as food security crop as well as food nutritional crop. As food security crop, it will enhance production adoption as well as improve the incomes of smallholder farmers through maintainable proceeds generation. Moreover, as food nutritional crop will enhance households at small scale levels with good health [16].

Chweya affirms that food utilization in relation to climate change can be affected directly through decreasing of densely rich micro nutrients plants or altering specific micro nutrients content through certain methods such as flooding [10].

2. Materials and Methods

2.1. Study Area

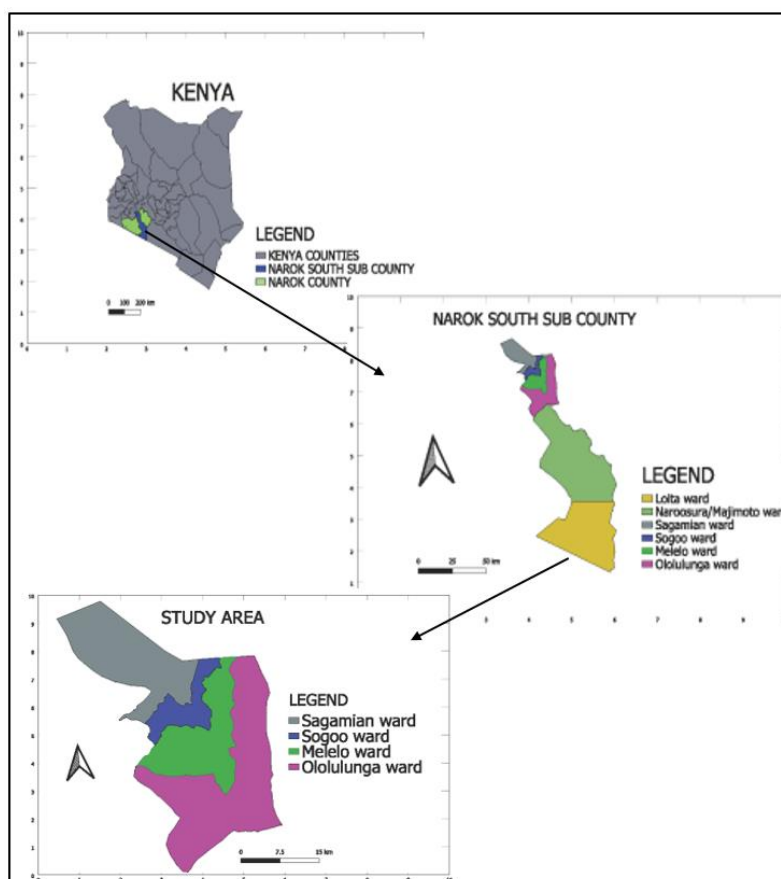


Figure 1. Map of study area in Narok south sub county.

This study was conducted in Narok south sub- county in Narok county-Kenya. Administratively, it has six (6) administrative Wards generally Sagamian, Sogoo, Melelo, Ololulunga, Loita and Maji-Moto / Naroosura. These six wards have a population of 238,301 with 46,723 households [35]. On coverage, it covers an area of approximately 4,959.20 km² and it is found in the South western side of Kenya [35].

The sub county borders Tanzania to the South, Narok west to West, Bomet to the North and Narok North to the East. Upper zone of the sub county practise crops production while lower zone practice pastoralism. Wards practicing Irish potato production includes Sagamian, Sogoo, Melelo and Ololulunga and is mainly produced by small scale farmers [19, 37, 38].

The sub county has a bi modal rainfall dispersal pattern. The long showers occur on March to May (MAM) and short rains occurs mid-October to December (OND). During this period Irish potato is planted by farmers and especially during long rains. The average annual rainfall ranges between 500-1800mm. Temperature ranges between 7 °C in July to 28 °C in January and March. Average temperature is 18 °C. This average rainfall and temperature is usually optimum for Irish potato production [2, 21].

2.2. Research Design

Target population for this study was small scale Irish potato

farmers in Narok south sub county Kenya. This study embraced two research designs which are cross sectional descriptive research design (survey) and explanatory research design (focus group discussions). These two research designs allowed the study to derive insights into the opinions, attitudes, perceptions, and knowledge regarding potato production strategies and consumption options amid climate change and variability. A cross-sectional descriptive survey design was used to understand Irish potato production and consumption at small scale farm levels. Explanatory research design on the other hand was used during focus groups discussion to understand Irish potato production and consumption trends across villages.

2.3. Sample Size and Sampling Procedure

This study embraced a multi-stage sampling procedure involving three stages within the study area. The first stage was purposively eliminating two wards from the study. area These are Loita and Naroosura/Majimoto wards. These two wards since across does not practise Irish potato production. The second stage involved villages selection within the remaining four wards which had high concentration of Irish potato production. The third and final stage involved random sampling of respondents within villages based on Kenya population survey of 2019 and using household as data collection point [36]. As indicated on the Table 1.

Table 1. Number of households and percentage sample size per ward.

	Wards	No of households	Percentage per Ward	Villages practising potato production	household sample
1.	Ololulung'a	6,161	28.8	66	113
2.	Melelo	6,280	29.4	54	116
3.	Sogoo	5,102	23.9	52	94
4.	Sagamian	3,837	17.9	43	70
	Total	21,380	100%	215	393

Sample size of respondent households were then calculated using [52] formula below.

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

The research used 95% confidence level with an error of 5% and after calculation 393 respondent households were interviewed; However, during data coding and entry 25 questionnaires didn't reach threshold to be analysed and therefore they were rejected leaving 368 questionnaires.

Focus groups discussion used quota sampling procedure to select groups for discussions. The study used controlled

sampling procedure where each focus group had between 10-12 members in size. The group consolidation considered gender, age and village of living. Twelve (12) focus groups discussion (three from each ward; Ololulunga, Melelo, Sogoo and Sagamian) were formed and the meetings were held at central points (fundamentally at a churches, assistant chiefs' boardroom or on a selected farmer residences). Similarly, key informant in-depth interviews samples were carried out at Sub county agricultural officer and ward agricultural officers.

2.4. Data Collection Procedure

Household data gathering procedure used questionnaires. The questionnaire was initially subjected to validity test through agricultural and academic experts. The questionnaires used amalgamation of both quantitative and qualitative data collection methods and hence both open ended and close ended questionnaires were used. These questionnaires were used by five (5) trained research assistants to gather data based on proportionate stratified random sampling interview for small scale Irish potato farmer's households. Household interviews were conducted through transect walk within the villages. The first interviewee within each village was sampled randomly and the next respondent depended on sample size within each village as indicated on Table 1.

During focus group discussions data collection procedure, a moderator was used to guide the interview discussions

process to gather data. The moderator was guided by interview guide which was developed earlier and therefore guided the group discussions and hence deviation from research area was avoided.

2.5. Data Analysis

Data got from the field was clustered according to category (cross sectional and focus groups). For cross sectional quantitative data, it was checked for correct entry, coded and then entered into the computer through Statistical Package for Social Sciences version 22.0 (SPSS 22.0) software program. Using this software program, data was evaluated to indicate statistical differences or relationships among variables. Chi-square was then calculated and inference made at a confidence level $\alpha=0.05$. Multiple linear regression analysis was calculated to test the hypothesis using below formulae.

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + \dots + b_nx_n \quad (2)$$

Where: Y= Irish potato production and consumption in tonnes/year

a = constants (i.e. land)

X1 = Certified Irish potato seeds availability (tonnes)

X2 = Maximum and Minimum temperatures (°C)

X3 = Rainfall and humidity (mm)

X4 = Earth skin temperature (°C)

X5 = Farmers endowment (Kenya shillings)

X6 = Agronomic practises (Days)

X7 = Irish potato value addition options (Numbers)

X8 = Agricultural extension information (Messages)

bnxn = Infinity of variables

that effects of climate change and variability on Irish potato production had greatly affected its production over the years. Only 1.9% within this category (below 25 years) who indicated that effects of climate change and variability have not affected Irish potato production over the years. This small percentage may be attributed to their age factor whereby they are entering into farming career and therefore they didn't have much experience. Those respondents aged over 65 years of age only 0.5% of them were unable to observe effects of climate change and variability against Irish potato production. This may be attributed to the fact that this category of the age group is more experienced on Irish potato production and due to their extensive experience of farming coupled with age factor they were able to note any change on production.

Those respondents aged between 26-35 years of age 11.4% outlined that climate change and variability has effect on Irish potato production while only 1.1% didn't see any effect of climate change and variability against Irish potato production. However, those respondents within age category of 36-45 majorities (17.1%) showed that climate change and variability has significantly affected Irish potato production over the years while only few (1.6%) didn't see any effect of climate change and variability against Irish potato production.

3. Results and Discussions

3.1. Effects of Climate Change and Variability on Irish Potato Production Across Age Groups Among the Respondents

Effects of climate change and variability against Irish potato production respondents across various age groups, respondent viewed differently (Table 2). Those aged below 25 years old, significantly (9.5%) of the respondents indicated

Table 2. Observation of potato production amid climate variability.

Observation of potato production amid climate variability	More affected		Less affected		Not affected	
	freq	%	freq	%	freq	%
Below 25 years	35	9.5	6	1.6	7	1.9
26-35	42	11.4	8	2.2	4	1.1
36-45	63	17.1	13	3.5	6	1.6

Observation of potato production amid climate variability	More affected		Less affected		Not affected	
	freq	%	freq	%	freq	%
46-55	98	26.6	15	4.1	5	1.4
56-65	37	10.1	2	0.5	4	1.1
Over 65	18	4.9	3	0.8	2	0.5
Totals	294	79.9	48	13.0	26	7.1

Source: Field data 2022.

For those respondents between age group 46-55 years' majority (26.6%) said that climate change and variability had significantly affected Irish potato production with only few (1.4%) had not observed any effects of climate change and variability against Irish potato production. May be this 1.4% of the respondents had just joined farming venture after retiring from formal sectors and now they were venturing into farming. This therefore did not give them enough practical experience in order to have divergent view of production trend over the years amid climate change and variability.

3.2. Source of Irish Potato Seeds Amid Climate Change and Variability

On Table 3 majority (71.5%) of the respondents got their seeds for planting from previous harvest. This significantly attributes that most farmers kept recycling their seeds therefore planting inferior seeds each and every season significantly contributing to low Irish potato production. Significantly 13.3% of respondents sourced their potato seeds from their neighbours while 8.4% of the respondents sourced their potato seeds from nearby market and only 6.8% of the respondents sourced their potato seeds from certified producers.

Table 3. Source of Irish potato seeds.

Source of Irish potato seeds	freq	%
From neighbours	49	13.3
From certified producer	25	6.8
From previous harvest	263	71.5
From market	31	8.4
Total	368	100.0

Source: Field data 2022.

From focus group discussions, the practise of recycling seeds and sourcing from neighbours who's their seeds are still from recycled harvest source is highly in the area. The reason

being that, farmers had confidence on quality of their own seeds and high assurance of seeds ready to be planted immediately the rain sets in. They also preferred neighbours' seeds as they could monitor the production growth of potatoes from planting, shooting up to harvesting. The main aim of this practise is to save cost incurred on farm expenses. Seeds from the market were least preferred since they never knew their source and their production. This phenomenon leads to less quantity and quality production of Irish potatoes over the years.

3.3. Coping with Seed Un Reliability Amid Climate Change and Variability

According to Table 4, majority (73.1%) of farmer's respondents indicated that when quality Irish potato seeds were not available they opted to plant those seeds which were available despite their shape, colour as well as diseased. From focus group discussions, the diseased potato seeds meant for planting are initially the diseased part is cut and thrown away. The left part is smeared with ash to prevent rotting and further penetration of disease. This scenario predicted that despite government effort to promote Irish potato farming, the production remains to dwindle if this trend continues. Substantial 65.8% of the respondents outlined that, they recycle the wares which they had harvested. Focus group discussions further outlined that farmers recycle their ware seeds up to a maximum of four seasons. This indicated that despite their production prowess on Irish potato production; the production kept declining due to recycling trend which kept low production each and every year.

Table 4. Coping with Irish potato seeds un reliability.

Coping with un reliability	Yes		No	
	freq	%	freq	%
Plant other crops	236	64.1	132	35.9
Lease land meant for Irish potato	119	32.3	249	67.7

Coping with un reliability	Yes		No	
	freq	%	freq	%
Reduce acreage of Irish potato	221	60.1	147	39.9
Plant that is available	269	73.1	99	26.9
Recycling the one harvested	242	65.8	126	34.2

Source: Field data 2022.

Handsomely 64.1% of the respondents responded by saying they planted other crops when they lacked Irish potato seeds. This implies that farmers plant what they can get in their farms instead of leaving it fallow for the next season. They see this as wastage of rainfall instead of seeing it as an increasing fertility into their farms. Significantly, 60.1% of the respondent reduced acreage of Irish potato and make immediate decision to plant another (other) food crop (s) in the plot intended for Irish potato initially. About (32.3%) of farmers leased out their land meant for Irish potato production to other farmers. From focus group discussion farms are only leased out when the farmer opts to abandon farming of Irish potato completely but as long as the farmer is on Irish potato farming then leasing out is not an option and not welcomed.

3.4. Harvesting and Handling of Irish Potato

From focus group discussions, Irish potatoes are ready for harvest when the shoot starts to wither. Farmers use slasher to slash the shoots with the aim of making faster tuber enlargement. To know that the wares are very ready for harvest, farmers will un bury few and determine the wares size. They also check peeling of the skin. Those wares which peel out easily are not ready for harvest but those which peel with a bit of difficult are ready for harvesting. After harvest it's followed with sorting and handling of the produce with aim of marketing or storage.

On Table 5 majority (78.5%) of respondent's produce their ware potato for market and through value chain actors. This phenomenon is even culminated by value chain actors offering services of harvesting and sorting Irish potato at cost. This indicates that value chain actors offer their services with aim of making more money from the farmer. Those good and appealing wares are sorted for the market while those which looked inferior and diseased on the other hand 37.5% of ware potato produced are meant for seed recycling/multiplication. significantly 32.6% of the ware potatoes produced is meant for household consumption and 27.7% of ware potato pro-

duced is meant for animal feeds.

Significant 55.7% of the respondent farmers aggregate their ware potatoes with neighbours for easier marketing and also to make sizeable load together for the truck loading. Minority of the farmers 18.5% responded that they put their wares on the diffuse stores especially those meant for seed multiplication. This implies that majority of the respondents 78.5% didn't have plan for their wares after harvesting apart from marketing and offloading it to the market. This scenario changes market dynamics where farmer gets little despite the efforts incurred on farming of Irish potatoes. This also implies that despite the farmer respondents working very hard on their farms producing Irish potatoes, in the end they opt to offload the highest quality into the market and left with inferior ones. The plausible result indicates that the respondents put market priority first instead of their household food security.

Table 5. Handling of Irish potato produce after harvest.

Handling of produce after harvest	Yes		No	
	Freq	%	Freq	%
Meant for market	289	78.5	79	21.5
Put them into diffuse store	68	18.5	300	81.5
Aggregate with neighbours	205	55.7	163	44.3
Store for home consumption	120	32.6	248	67.4
Sort for seed for next season	138	37.5	230	62.5
Sort for animal feeds	102	27.7	266	72.3

Source: Field data 2022.

3.5. Transport of Irish Potato from Farm to Market

On Table 6, majority (74.7%) of respondents' farmers indicated that they use donkeys to transport their ware potato from their farm into the market. The reason being that, roads within the area are not conducive for other means of transport. Furthermore, donkeys are relatively cheap as mode of transport though time consuming. With increase of motorcycles in the country, transport using this means (motorcycles) had started to become common in the area with 63.6% of the respondents using it. However, during focus group discussions respondents pointed out that motorcycle carries limited load capacity and expensive in comparison to the use of donkeys. Moreover, motorcycle could not penetrate those areas where road networks are dilapidated.

Table 6. Transport of Irish potatoes from farm to market.

How do you transport potatoes from farm to market	Yes		No	
	Freq	%	freq	%
Use donkey	275	74.7	93	25.3
Use of shoulder/back	212	57.6	156	42.4
Use of motor cycles	234	63.6	134	36.4
Marketer comes for them at farm	188	51.1	180	48.9

Source: Field data 2022.

Use of shoulder/back, a sizeable 57.6% of respondents responded that, they use it to transport ware potato from household to market or to an aggregator point where other means of transport could not reach. Marketer transport options were 51.1% and were least used. The reason being most marketers according to respondents were money oriented and they only preferred places where they couldn't incur extra cost from their agreed cost. They preferred only to take ware potatoes from the point where they can be able to load into their trucks.

3.6. Consumption and Utilization of Irish Potato Amid Climate Change and Variability

About 35.3% of the respondents agreed that they use Irish potato as an accompaniment to other foods. Significantly 33.2% of the respondent indicated that, they consume Irish potato as main dish when they didn't have anything else to eat. A sizeable 32.6% of the respondents consume Irish potatoes when boiled and mashed, 31.5% of the respondents consume it when roasted. 25.3% of the respondents consume it as French fries (chips), 24.7% of the respondents consume it as crisps, and 22.3% of the respondents stewed it for consumption while only 19.0% of the respondents make dried potato chips which are later deep fried (Table 7).

Table 7. Consumption and utilisation of Irish potato in Narok south sub county.

Irish potato Utilization	Yes		No	
	freq	%	freq	%
As main dish	122	33.2	246	66.8
As accompaniment	130	35.3	238	64.7
As French fries	93	25.3	275	74.7
As crisps	91	24.7	277	75.3
As stewed	70	19.0	298	298

Irish potato Utilization	Yes		No	
	freq	%	freq	%
Roasted	116	31.5	252	68.5
Boiled and mashed potatoes	120	32.6	248	67.4
Dried potato chips	82	22.3	286	77.7

Source: Field data 2022

Irish potato consumption across different age groups (Table 8) indicated that consumption of Irish potato as main dish (staple food) only 4.3% of respondents aged 25 years and below consumed it as main dish, A sizeable 4.6% of respondents aged between 26-35 years consumed it as main dish, About 7.1% of the respondents aged between 36-45 years consumed as main dish, Significant, 10.3% of the respondents aged between 46-55 years consumed it as main dish, nearly, 4.9% of the respondents aged between 56-65 years consumed it as main dish and only 1.9% of the respondents above 65 years consumed Irish potato as main dish. This indicates that only 33.2% of total respondents interviewed consumed Irish potato as main dish. The least preferred method of Irish potato consumption and utilisation method was making dried potato chips with only 1.1% of respondents below 25 years doing it and majority (4.9%) of the respondents aged between 46-55 years were making dried potato chips.

The study further indicated that those respondents above 65 years; 4.1% of the respondents consumed Irish potato in form of boiled and mashed, very significant 2.4% of them consumed Irish potato in roasted diet. While only 1.1% of the same category respondent's occasional made French fries in their homes and only 0.5% of this age respondents make crisps in their homes.

From focus group discussions respondents indicated that, they tried to make dried potato chips and failed and more potatoes are consumed by those people who are much older than young generations". Further they outlined that older

people (above 65 years old) they prefer roasted potatoes than other methods and especially taken during morning hours as breakfast.

Table 8. Irish potato consumption and utilisation across age groups amid climate change and variability in Narok south sub county.

Irish potato consumption and utilization	Below 25 years		26-35		36-45		46-55		56-65		Above 65 years		Totals	
	Frq	%	Frq	%	Frq	%	Frq	%	Frq	%	Frq	%	Frq	%
As main dish	16	4.3	17	4.6	26	7.1	38	10.3	18	4.9	7	1.9	122	33.2
As accompaniment	20	5.4	20	5.4	32	8.7	37	10.1	15	4.1	6	1.6	130	35.3
As French fries	18	4.9	16	4.3	16	4.3	31	8.4	8	2.2	4	1.1	93	25.3
As crisps	16	4.3	9	2.4	23	6.3	28	7.6	13	3.5	2	0.5	91	24.7
As stewed	4	1.1	5	1.4	16	4.3	18	4.9	17	4.6	10	2.7	70	19.0
Roasted	7	1.9	13	3.5	29	7.9	42	11.4	16	4.3	9	2.4	116	31.5
Boiled and Mashed potato	3	0.8	10	2.7	23	6.3	47	12.8	22	6.0	15	4.1	120	32.6
Dried potato chips	3	0.8	4	1.1	16	4.3	30	8.2	14	3.8	15	4.1	82	22.3

Source: Field data 2022

Chi square test analysis and Pearson product moment correlation of Irish potato consumption and utilization across age groups showed statistical significance as shown on [Table 9](#).

Table 9. Chi square test analysis and Pearson product moment correlation of Irish potato consumption and utilisation against age groups.

Irish potato consumption and utilisation across age groups	Chi square test analysis			Pearson product moment correlation
	χ^2	df	p	r
As main dish	1.742	5	0.884	-0.22
As accompaniment	3.082	5	0.687	0.076
As French fries	7.615	5	0.179	0.109
As crisps	8.220	5	0.145	0.052
As stewed	28.679	5	0.000	-0.229
Roasted	10.496	5	0.0062	-0.149
Boiled and mashed potatoes	41.496	5	0.000	-0.335
Dried potato chips	42.165	5	0.000	-0.310

3.7. Farm Level Value Addition of Irish Potato Amid Climate Change and Variability

From focus group discussions farmers add value their wares at farm level through removing dirt from wares, sort-

ing those damaged and diseased, grading wares into three grades (Big (large), medium and small). The large sizes are specifically meant for bigger markets including industries which are in Nairobi and Nakuru while medium ones are meant for nearby local and urban markets. Small ones are sold by farmers to other farmers as seeds for next season.

Rigorous sorting leaves a farmer with small inferior wares. These inferior wares are the one the farmer saves for his household consumption and also as seeds for the next season as indicated earlier. This scenario leads to dwindling of Irish potato production despite high promotion by the government.

According to Table 10, a significant 92.9% of farmers were taking an initiative on removing dirt on their ware potatoes so that they can be able to increase sale and also due to the

pressure from value chain actors who don't carry dirty ware potatoes. Only 23.1% of the respondents make French fries/chips in their homes and sell it to their neighbours. Majority (76.9%) didn't know how to make French fries in their homes nor sell it to their neighbours. Similarly, very small significant 21.5% of the respondents know how to make crisps with 78.5% admitted that they didn't know how to make crisps and therefore they can't sell it to their neighbours.

Table 10. Value addition of Irish potato amid climate change and variability.

Value addition of Irish potato at farm level	Yes		No	
	Freq	%	freq	%
Removing dirt	342	92.9	26	7.1
Sorting and grading	322	87.5	46	12.5
Sourcing market	134	36.4	234	63.6
making French fries/chips	85	23.1	283	76.9
Making crisps	79	21.5	283	78.5
Storage for future marketing	68	18.5	300	81.5

Source: Field data 2022.

Substantial 87.5% of respondents indicated that, they do sorting and grading of the wares as dictated by value chain actors' grading conditions. Only 18.5% of respondents admitted that they store for future market. This indicates that 81.5% didn't know Irish potato storage methods.

From focus group discussions, French fries/chips are food for the youth and children in fast food restaurants in towns. Similarly, crisps are meant for children and only bought in outlet stores in towns. Grown up people don't eat crisps or chips at home or in fast food restaurants. In fact, men outlined that, they do not consume crisps and French fries as they are meant for children. Farmers also outlined that they do not source market for their wares but off load it to the value chain actors. Due to this factor, value chain actors take advantage of the farmers and therefore they dictate the price of the ware potatoes.

3.8. Farming Challenges Faced During Irish Potato Production Amid Climate Change and Variability

At farm level according to Table 11, Proliferation of pest and disease was highly observed by about 82.3% of the respondents indicating that it was becoming menace on Irish potato farms. While 13.9% of the respondents had minimal observation and only 3.8% of the respondents didn't observe any proliferation of pest and disease on their farms. Majority (79.3%) of respondents highly observed weed infestation while 12.0% had minimal observation and only 8.7% of the respondents didn't observe any weed infestations on their farms (Table 11).

Table 11. Irish potato production challenges amid climate change and variability.

Challenges of farming	Highly observed		Minimal observed		Not observed	
	frq	%	frq	%		
Increase cost of land operations per unit area (acre)	275	74.7	77	20.9	16	4.3
Reduced quality of potato produce	252	68.5	79	21.5	37	10.1
Reduced motivation to provide credit by creditors	189	51.4	109	29.6	70	19.0

Challenges of farming	Highly observed		Minimal observed		Not observed	
	frq	%	frq	%		
Lack of scientific and technical information systems on climate change and variability	216	58.7	94	25.5	58	15.8
Counterfeit inputs	258	70.1	82	22.3	28	7.6
Low harvest per acre	236	64.1	88	23.9	44	12.0
Pest and diseases proliferation	303	82.3	51	13.9	14	3.8
Household Financial constraints	277	75.3	76	20.7	15	4.1
Land degradation on potato farms	201	54.6	118	32.1	49	13.3
Inadequate rainfall	271	73.6	73	19.8	24	6.5
High weed infestations	292	79.3	44	12.0	32	8.7
Persistent Irish potato failure	244	66.3	74	20.1	50	13.6
Lack of agricultural extension messages	211	57.3	81	22.0	76	20.7
Dilapidated infrastructures	213	57.9	73	19.8	82	22.3

Source: Field data 2022.

Substantial 75.3% of the respondents highly outlined that household financial constraints were also their major hindrance on Irish potato production especially with current hard economic times, while 20.7% had minimal observation and only 4.1% of the respondents didn't observe any household financial constraints. In this study 74.7% of the respondents had highly observed increase of land operation costs on their Irish potato farm while minimal 20.9% of the respondent had observed significant increase of land operations costs and only 4.3% of the respondents didn't observe any increase on farm operation costs.

Significantly 73.6% of the respondents highly outlined that inadequate rainfall due to climate change and variability was also a major hindrance in cultivation of Irish potato. While 19.8% had minimal observation and only 6.5% of the respondents didn't observe any inadequate rainfall due to climate variability. Counterfeit input was also highly outlined by 70.1% of the respondents as a challenge toward maximum Irish potato production. While 22.3% had minimal observation and only 7.6% of the respondents didn't observe any presence of counterfeit products on their farming experience.

Reduced quality of potato produce was also highly recognised by 68.5% of the respondents as threat to Irish potato production. While 21.5% had minimal observation on reduced quality of Irish potato and only 10.1% of the respondents didn't observe any quality reduction of Irish potato on their farms. For soil degradation 66.3% of the. While 20.1% had minimal observation and only 13.6% of the respondents didn't observe any low harvest of Irish potato per acre due to low soil fertility.

Lack of scientific and technical information systems on climate change and variability was highly outlined by 58.7%

of respondents as major hindrance on Irish potato production while 25.5% minimally outlined it as major hindrance and only 15.8% of the respondents didn't outline lack of scientific and technical information systems on their farming experience as major hindrance. This may be attributed to the fact that majority of the farmers had gained practical experience on Irish potato production and those yet relied on their neighbours, parents and siblings and agricultural officers for training. Road infrastructural is very key element on Irish potato production as serious dilapidated roads proves very difficult to transport Irish potatoes from farms to the market [3]. In this research 57.9% of the respondents highly observed dilapidated infrastructures in their area hindering smooth Irish potato cultivation while 19.8% had minimal observation of dilapidated roads and only 22.3% of the respondents didn't outline any dilapidated road infrastructures in their area hindering smooth Irish potato production movement.

In this study about 57.3% of the respondents highly observed lack of agricultural extension messages hindering smooth Irish potato cultivation while 22.0% had minimal observation and only 20.7% of the respondents didn't outline lack of agricultural extension messages. On soil test analysis majority (79.9%) of respondents didn't carry soil test analysis of their land to determine the deficient nutrients on their soils. Majority 51.4% of the respondents also highly outlined challenge of credit advancement by banks and Sacco's, 29.6% of respondents had minimal observation and only 19.0% of the respondents didn't observe any challenge on credit facilities.

From focus group discussions, it was stated that, those farmers who had financial handicap relied on merry go round contributions where members pooled resources together and give it to one of their member each month until the last

member is given. With this, those who were financially handicapped were setting the date to be given to coincide with their planting of Irish potatoes. Farmers also stated that impact of climate change and variability had led them to have dwindling harvest per acre of Irish potato each and every year. The highest challenge of farming of Irish potato within the area was outlined as proliferation of counterfeit inputs especially agro chemicals which was rampant in the area and this

forces farmers to spray different types of chemicals at the same time targeting the same host, moreover Potato bacterial blight (*Phytophthora infestans*) was outlined by respondents as menace to Irish potato production in the area.

Chi square test analysis and Pearson product moment correlation of age against Irish potato production challenges indicated statistical significance as shown on Table 12.

Table 12. Chi square test analysis and Pearson product moment correlation of Irish potato production challenges against age amid climate change and variability.

Irish potato production Challenges against age of the respondents	Chi square test analysis			Pearson product moment correlation
	χ^2	df	p	r
Increase cost of land operations per unit area (acre)	32.962	10	0.000	0.356
Reduced quality of potato produce	46.200	10	0.000	0.176
Reduced motivation to provide credit by creditors	91.746	10	0.000	0.109
Lack of scientific and technical information systems on climate change and variability	36.165	10	0.000	-0.081
Counterfeit inputs	59.365	10	0.000	0.229
Low harvest per acre	32.862	10	0.000	-0.159
Pest and diseases proliferation	18.913	10	0.040	0.335
Household Financial constraints	1.143	10	0.000	-0.033
Land degradation on potato farms	4.490	10	0.923	-0.223
Inadequate rainfall	1.150	10	0.000	0.056
High weed infestations	49.101	10	0.000	0.102
Persistent Irish potato failure	53.537	10	0.000	-0.084
Lack of agricultural extension messages	52.506	10	0.000	-0.249
Dilapidated infrastructures	5.166	10	0.880	-0.168

4. Conclusion and Recommendations

From the study, the findings show that climate change and variability has influence on Irish potato production and consumption therefore affecting food security and availability in Narok county. This climate change and variability leads to variation on Irish potato production and consumption as there was evident that there was low production and value addition options of Irish potato at farm levels. Practice of recycling seeds and sourcing from neighbours who's their seeds were still from recycled harvest source was highly in the area. Coupling this phenomena and impact of climate change and variability led them to have dwindling harvest per acre of

Irish potato each and every year. It is from this back ground information that this study recommends that, the agricultural extension agents within the area should endeavor to train farmers on positive potato seed selection or similarly direct farmers where they can get certified quality Irish potato seeds. Further to this they should strive to train farmers on various Irish potato value addition options. Putting this in place will not only increase food security within their households but will also equip them with up to date information and therefore help them make informed decision on Irish potato production and value addition strategies.

Abbreviations

FAO Food and Agriculture Organisation

FAOSTAT	Food and Agriculture Organization Statistical Database
GoK	Government of Kenya
IFPRI	International Food and Policy Research Institute
ILRI	International Livestock Research Institute
JICA	Japan International Cooperation Agency
KNBS	Kenya National Bureau of Statistics
KPHC	Kenya Population and Housing Census
MOA	Ministry of Agriculture
MOALF	Ministry of Agriculture, Livestock and Fisheries
NPCK	National Potato Council of Kenya
SPSS	Statistical Package for Social Sciences
UN	United Nations

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Author Contributions

Francis Njoroge Kabochi: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing - original draft

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Data Availability Statement

All the data reported here are available from the authors upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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