Assessment of Potato Production Technologies Among Smallholder Farmers in Marakwet West Sub-County, Elgeyo Marakwet County, Kenya

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Abstract

Potato is a major food and cash crop in the Kenyan highlands, widely grown by small-scale farmers. However, its productivity has been declining over the years in Marakwet West. Thus, this study determined factors affecting Potato production among smallholder farmers in Marakwet West Sub- County, Elgeyo Marakwet County. A survey was conducted in Moiben/ Kuserwo, Cherang'any/ Chebororwa, Lelan and Kapsowar ward in Marakwet West Sub-County. During the survey, smallholder potato farmers totaling 137,513 were targeted for the study of which a sample of 173 of them who were selected via random sampling was administered with semi-structured questionnaires. Descriptive analysis of the data collected was conducted using SPSS and Microsoft Excel. The results showed that most farmers were not trained in potato production technologies. However, those who received training on potato production technologies implemented the technology on their farms. The potato production technologies enabled the farmers to improve on their yields, economized on input usage and control of pest and disease. Safe and effective uses of pesticides were potato production technologies applied. However, the farmers did not use the certified seed of Shangi variety instead they sourced seeds from other farmers because the seeds were not available, expensive, lacked information and it was a new product to them. The certified seeds of potatoes should be produced via tissue culture technology and should be affordable and accessed by the farmers.

Keywords: Potato, Technology, Farmers, Assessment, Marakwet West

INTRODUCTION

Potato (*Solanum tuberosum*) is one of the crops cultivated by farmers worldwide. It is the world's fourth largest consumed crop after wheat, rice and maize (FAO, 2019). Potatoes are grown mostly for local consumption, while little is exported by some countries. The maturity of Potatoes is 3-4 months and could yield about 40 tons/ha and thus, it is suitable in regions where land is small size and abundant labour (FAO, 2014). Potato production in the world in 2021 was done on about 18.1 million hectares of land. China is the leading country with about 5.782 million hectares of land. It is followed by China mainland with 5.780 million hectares and India with 2.248 million hectares (FAOSTAT, 2021). The world Potato production was approximately 18.1 million tons China was ranked first in world potato production with a production of 9.46 million tons, China mainland was ranked second with 9.43 million tons and India was ranked third with 5.42 million tons. It is seen that the countries that have a say in the world production in the last five years are China and India. Being the leader in the world, China meets 25 % of the world's total production in 2021(FAOSTAT, 2021).

Nigeria was the leading in terms of land size under potato production in Africa (319,180 ha). It is then followed by Egypt and Kenya with 262,706 ha and 214,600ha, respectively. However, in terms of production, Egypt was the leading Country in Africa in potato production with 6,902,816 tonnes followed by Algeria and South Africa with 4,360,880 tonnes and 2,595,280 tonnes, respectively. Kenya was ranked 4th with 2,107,824 tonnes despite being ranked 3rd in terms of land area under potato (FAOSTAT, 2021).

The average production in Kenya is estimated at 10 MT per hectare (FAOSTAT, 2021) compared to a global average yield of 17 MT per hectare (FAOSTAT, 2019). Additionally, smallholder, medium scale and large-scale farmers undertake Potato production. The smallholder farmers constitute about 800,000 engage in potato production and are estimated to cultivate about 83% of land under potato production, which is between 0.2 to 0.6 hectares of land, while 17 per cent of potato cultivation belongs to medium to large scale farmers who cultivate 2 to 10 hectares of potato (Janssens et al., 2013).

Potatoes are mainly grown in the highlands of Central, Eastern and Rift Valley regions in Kenya. These areas include slopes of Mt. Kenya, the Mau escarpment, the Nandi escarpment, Cherang'any hills and the slopes of Mount Elgon (Kirumba et al., 2004). The altitude of these areas ranges between 1500-3000 metres above sea level (Kiiya et al., 2006). There are two potato cycles due to bimodal rainfall in several potato producing regions (USAID-KAVES, 2014). There are at least 30 potato varieties that are grown in Kenya, but *Shangi* and *Tigoni* were the most cultivated varieties because of its high market demand and farmer preference (Kaguongo et al., 2010).

Agricultural technologies can contribute to poverty reduction, by raising the incomes of farm households and, in some cases, providing new employment opportunities for landless labourers (Noltze et al., 2013). The potato production is faced with myriad of challenges that can be addressed by technological means. The seasonality in production, lack of on-farm ware potato storage, high transaction costs, price inefficiencies and quality losses lead to low returns to the farmers (Kaguongo, et al., 2008). The producers' lack market information and the perishability nature of potatoes coupled with price fluctuation contribute to low returns to the farmers. Also, the poor infrastructure network makes the transportation of potatoes to the market expensive (Hoeffler, 2005). Besides, the productivity of potato is 7.5 tonnes (FAO, 2008) and this is below the 50 tonnes, which is the potential yield. This has been attributed to poor technological adoption that includes low application of fertilizers and agrochemicals, inadequate quality seed and challenges associated with climate change (CIP, 2011). Farmers in Marakwet West constituency have been experiencing low production of potato per acre, thus poses a challenge to poverty reduction and a thread to food security. Therefore, there was a need to assess production technologies among smallholder Potato farmers in Marakwet West Sub- County, Elgeyo-Marakwet County in view of improving food security, employment and income for the farmers.

METHODOLOGY

Study Area

Marakwet west sub-county is located in Elgeyo Marakwet County, Rift Valley. It borders West Pokot County to the North, Baringo County to the East, South East and South, Uasin Gishu County to the South West and West and Trans Nzoia County to the North (Figure. 1) (County Government of Elgeyo Marakwet, 2013)

The Highlands receive between 1200mm and 1500mm per annum, while the escarpment and the Kerio Valley receive rainfall ranging between 1000mm to 1400mm per annum. In altitude, the Highland plateau rises from an altitude of 2700 meters above sea level on the Metkei Ridges in the South to 3350 metres above sea level on the Cherang'any Hills to the North. Temperatures range from a minimum of 14 °C to a maximum of 24 °C. Rainfall ranges annually from 400 to 1,400 mm. (County Government of Elgeyo Marakwet, 2013).

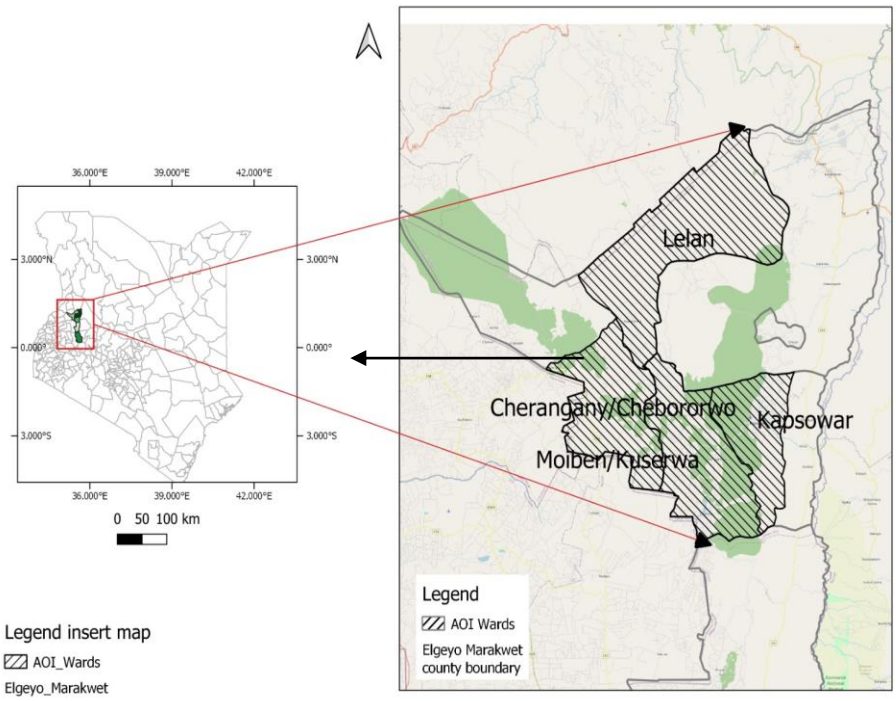

Figure 1: Map of the Study Area

Research Design

The study employed a descriptive study design. This is about what, where and how of a phenomenon (Cooper et al., 1994). The study was undertaken for purposes of ascertaining and describing the potato production technologies, perception of available varieties and sustainable practices to give it a profile. The descriptive design sought to establish and describe the situation with stakeholders at various levels of the potato value chain and elaborate means of addressing the opportunities and constraining factors to optimal functioning of the production.

Target Population

The target population refers to a group of people or study subjects who are similar in one or more ways and which forms the subject of the study in a particular study. The study targeted 137,513 farmers for the purposes of the study (Table 1). The targeted population was according to the 2019 Population and Housing Census (KNBS, 2019).

Sampling Techniques

Marakwet west Sub-County is divided into six wards, namely Chebororwa/ cherang'any, Lelan, Moiben/Kuserwo, Sengwer, Kapsowar and Arror. A simple random sampling technique was employed in selecting four wards, namely Chebororwa/ cherang'any, Lelan, Moiben/Kuserwo and Kapsowar ward. Also, a simple random sampling was used to select the villages and the farmers from the study area.

Sample Size

To obtain information about population of interest and to draw inference about the population, researchers use sample, which is a subgroup of the population (Lind et al., 2008). According to (Sumukwo et al., 2013) to get the desired sample, the following formula was being applied.

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where n = Sample Size, N is Population Size, C is Coefficient of Variation (30%), e is Standard error of 2 percent

From the formula n=224 sample population of Marakwet West sub county

The sample size of 224 was for the six wards of Marakwet west, namely Chebororwa/ cherang'any, Lelan, Moiben/Kuserwo, Sengwer, Kapsowar and Arror ward. From the six wards, Chebororwa/ cherang'any, Lelan, Moiben/Kuserwo and Kapsowar ward were selected for the study (Table 1).

Table 1: Target population and sample size

Sub county	Adult population	Sample population	Sampled Wards	Sample population per sampled wards	Sample size
Marakwet west	66,763	224	Cherang'any /Chebororwa	11,195	38
			Lelan	12,389	42
			Moiben/Kuserwo	11875	40
			Kapsowar	15,662	53
Total	66,763	224		51,121	173

Source: Author, 2022

The study therefore employed a sample of 173 farmers.

Data Collection

Data was collected between 1st may to 30th may 2022.Simple random sampling was used to select the 173 smallholder Potato farmers from the four wards. The farmers were interviewed and questionnaires administered to them. The questionnaire consisted of two sections; one on general information and the other on detailed survey. In the detailed survey section, information was gathered through direct entries, choice options or selection of respondent assessment on a 5 point Likert type scale.

Methods of Data Analysis and Presentation

The descriptive analysis was done by use of Microsoft excel and Statistical Package for Social Sciences (SPSS) software. The mean, standard deviation, frequencies and percentages were presented in tables.

RESULTS AND DISCUSSIONS

Demographic characteristics of the farmer

The study assessed the demographic features of the respondents such as gender, age and education level as presented in tables 2, 3 and 4 below.

Gender of the respondent

The proportion of gender of the respondents presented inform of frequencies and percentages in table 2 below.

Table 2: Gender of the respondent

Gender	Frequency	Percentage (%)
Female	65	37.6
Male	108	62.4
Total	173	100

Male farmers dominated Potato production at 62 per cent. Female farmers accounted for approximately 38% of all farmers surveyed (Table 2). This means that the male farmers did the technological decision of the Potato production. Manishimwe et al. (2019) found similar results in Rwanda. Also, Mwanja et al. (2016) found that there was a high probability of male farmers adopting potato technology than female farmers in South Western Uganda.

Age of the respondent

The potato farmers' age information ranging from 20-70 years as presented in table 3 below.

Table 3: Age of the respondent

Age (years)	Frequency	Percentage
20-30	36	20.8
31-40	52	30.1
41-50	60	34.7
51-60	20	11.6
61-70	5	2.9
Total	173	100

Potato producers ranged in age from 41 to 50 (34.7%). The aging population of 61-70 (2.9%) years of age were the least number of the producers of Potato. The 31-40, 20-30 and 51-60 age groups comprised 30%, 21% and 12% of all farmers respectively (Table 3). This suggests that middle-aged farmers dominate Potato production as they were likely to be endowed with skills and energy to produce the quality and quantity Potatoes. Mengui et al. (2019) stated that age was the determining fact of technical efficiency among Potato farmers.

Education level

The respondents' level of education has been divided into four categories and each category is represented by corresponding frequency and percentage in table 4.

The majority of the farmers attained the secondary level of education (51%). Those that had attained primary level of education, tertiary level of education and with no formal education were about 30%, 17% and 2% of the total number of farmers, respectively (Table 4).

Table 4: Education level

Education level	Frequency	Percentage (%)
No Formal education	4	2.3
Primary education	51	29.5
Secondary education	88	50.9
Tertiary education	30	17.3
Total	173	100

This means that farmers had an adequate level of education to apply Potato technology. The education level of a farmer determines the productivity of Potatoes. Hence, the study found out that the farmers had the sufficient level education to comprehend and execute the Potatoes production technologies. Worku (2019) concurs with it that education level of the farmers increases the probability of the adoption of potato technology Oromia regional state Western Sewa in Southern Ethiopia.

Social economic activities of the farmers

The social economic activities of the farmers such as farmers' group affiliation, farming experience and land size have been presented below (Table 5, 6 and 7).

Farmers group

The responses from the smallholder potato farmers' affiliation to a farmer group or not have been presented in Table 5.

Table 5: Farmers group

Farmers group	Frequency	Percentage (%)
Yes	156	90.17
No	17	9.83
Total	173	100

The farmers group plays an important role in knowledge dissemination. In that study, the members of a group were 90% and those without a group were approximately 10% of the total number of farmers (Table 5). This indicated that, those farmers' groups were predominant in the region. This promoted sharing of Potatoes technologies in view of producing quality and quantity produce. Similarly, Ketema et al. (2016) reported that farmers belonging to cooperatives and social institutions foster the adoption of technologies in Nakuru County in Kenya.

Farming experience

The different levels of farming experience of the respondents in years and its respective frequencies and percentages have been presented below in Table 6.

Table 6: Farming experience

Farming experience (years)	Frequency	Percentage (%)
0-5	106	61.3
5-10	49	28.3
10-15	4	2.3
Over 20	14	8.1
Total	173	100

Farming experience is integral to the productivity of the Potato. The majority of the farmers had 0-5 years (61%) in the production of Potato. Farmers aged 5-10, over 20, and 10-15 were found at approximately 28%, 8% and 2% of the total number of

farmers respectively (Table 6). Farmers' agricultural experience has sufficed to ensure good Potato production. Farmer's experience was one of the significant determinants of technical efficiency among Potato farmers (Mengui et al., 2019). Besides, farmers' experience in Potato production had positive effects on the adoption of new technologies (Selahkwe et al., 2021).

Land size

The land size under potato production and its respective frequency and percentage is presented below (Table 7).

Table 7: Land size

Land size (acres)	Frequency	Percentage (%)
Below 5	151	87.3
5-10	19	11
10-15	2	1.2
Above 20	1	6
Total	173	100

Most of the farmers were operating at a land size of below 5 acres (87%). The farmers were running on land size above 10 acres were about 7% of the entire number of farmers (Table 7). This means that the smallholder farmers-controlled Potato production. Smallholder farmers with land size of below 5 acres practiced Potato production. This was as a result of land subdivisions, which was prevalent in the area due to increasing population rate. Similar results were found by Omiti et al. (2009) that smallholder farmers practice Potato production in Kenya with a land size below 5.

Farmers training on agricultural extension and Technology and its implementation

The results of farmers on training of on agricultural extension and technology, and technology implementation has been presented in the table 8 and 9, and discussed below.

Training on agricultural extension and Technology

The response of potato farmers on whether they received training or not on agricultural extension and technology is presented in table 8 below.

Table 8: Training on agricultural extension and Technology

Training	Frequency	Percentage (%)
Yes	64	37
No	109	63
	173	100

The majority of the farmers claimed that they did not receive training on agricultural extension and technology (63%). Those who received an agricultural extension and technology were 37% of the total number of farmers (Table 8). This means that a small number of farmers received training on agricultural extension before planting Potato in their farms. This enabled the farmers to apply the current technologies to improve on their yields, economizes on input usage and control of pest and disease. Equally, Selahkwe et al. (2021) found out that in order to produce a high production rate of Potatoes, training of experienced farmers and providing them with of improved potato seeds was necessary.

Technology implementation

The response of potato farmers on whether they implemented the technology or not during potato production is presented in table 9 below.

Table 9: Technology implementation

	Frequency	Percentage (%)
Yes	136	78.61
No	37	21.39
	173	100

Most of the farmers implemented on agricultural technology received from the training (79%), whereas about 21% of them did not (Table 9). This indicates that farmers implemented the technology they receive from trainings.

To assess the farmers' perception of Safe and effective use of pesticides

The farmers used pesticides in the Potato production in their farms. The farmers' perception on the safe and effective use pesticides was analysed and presented below. (Table 10).

Table 10: Safe and effective use of pesticides

Variable	Frequency	Per cent (%)
Strongly disagree	6	3.5
Disagree	8	4.6
Undecided	3	1.7
Agree	18	10.4
Strongly agree	138	79.8
Total	**173**	**100**

The safe and effective usage of pesticides was practiced by most of the farmers (90.2%). The farmers who practiced on the contrary were 8.1%. The undecided farmers were only 2% of the entire number of farmers (Table 10). This indicates that farmers were knowledgeable on the safe and effective use of the agrochemicals. The safe and effective use of pesticides was done courtesy of availability of chemical usage manuals and trainings administered by agrochemical industries' agronomist. Kurui et al. (2014) stated that farmers were knowledgeable of pesticide usage and was determined by the level of education. On the contrary, the study thereof, found out that the farmers did not exercise safety measures when handling, mixing and spraying chemicals such as wearing protective clothing.

To establish the planting materials and the reason for not using certified Potato seeds

The varieties of potatoes available and rejected in the region, source of planting materials and Reasons for not using certified Potato seeds by the smallholder farmers have been analyzed and presented in table 11 and 12, and discussed.

Variety available in the region

The smallholder potato farmers' preferences of potato variety are presented in table 11 below.

Table 11: Variety available in the region

Variety	Frequency	Percentage
Shangi	173	100

Shangi was the variety that the farmers grow in the region. This is explained by adaptive capacity and strong market demand (Table 11).

Varieties rejected in the region

The smallholder potato farmers' response on the varieties that they rejected were analyzed, presented in table 12 below.

Table 12: Varieties rejected in the region

Variety	Frequency	Percentage
Kerr's Pink	2	1.2
Asante	3	1.7
Tigoni	168	97.1
Total	**173**	**100**

Tigoni was the most rejected variety in the region (97%). The other varieties rejected were *Asante* (1.7%) and *Kerr's Pink* (1.2%). These varieties were rejected due to their low production trend (Table 12).

Source of planting materials

The farmers' source of planting materials was analyzed and presented in table 13 below.

Table 13: Source of planting materials

Variable	Frequency	Percentage (%)
Certified seeds	1	0.6
Own seeds	72	41.6
From other farms	100	57.8
Total	173	100

Most of the farmers sourced Potato seeds for planting from other farms (58%), while about 41 % of them utilized seeds from their own farms. Only 0.6% of farmers used certified seed during planting of Potatoes (Table 13).

Reasons for not using certified Potato seeds

The reason for not utilizing the certified Potato seeds were given by farmers and it has been presented in table 14 below.

Table 14: Reasons for not using certified Potato seeds

Variable	Score	Rank
Certified seeds are New products to them	7	3
No information on certified seeds	2	4
Certified seeds not available	163	1
Certified seeds not affordable	69	2

There were several reasons why farmers did no use certified seeds during planting. Most of the farmers stated that the certified Potato seed were not available to them. The Other reasons given by the farmers where the certified seeds were not affordable to them, that they had no information on the certified seeds and it was a new product to them (Table 14). This has led to the low yields experienced in the region against the potential yields. Njagi et al. (2018) found out that indeed farmers are constrained in

accessing quality certified seeds and that Okello et al. (2016) revealed and found that the distance to the market, household food insecurity and asset endowment influenced the decision to use Certified seeds of potatoes. If the farmers' access the certified seeds, coupled with good management, Hassen (2015) revealed that the yield will improve.

The impact of the application of technology on Potato production

The smallholder Potato farmers' response on the impact of the application of technology on potato production is presented below (Table 15).

Table 15: The impact of the application of technology on Potato production

Variable	Score	Rank
Improved yield	146	1
Improved market for products	20	3
Economized on inputs usage	4	4
Pest and disease control	84	2

The farmers claimed that the technology they implemented improved the Potato yield. Other benefits that farmers gained from implementing the technology were pest and disease control, input economics and improved market for Potato products (Table 15). It shows that the technology was helpful to the farmers. Besides, Naz et al. (2011) found out that NPK fertilizers enhanced yield and quality of potato tubers and this improved the market of Potato. Gebre et al. (2001) revealed that optimum yield of Potatoes depends on correct spacing whereas, Shep Plus (2019) pointed out that agrochemicals are part of the main farm inputs required in potato production as it control pest and disease.

CONCLUSION AND RECOMMENDATION

The study assessed the Potato production technologies among smallholder farmers in Marakwet west sub-county. The fact that the households were headed by male denotes the ultimate decisions about the Potato production are a male responsibility. Besides, the farmers were smallholder farmers operating at land size between 0-5 acres. In addition, farmers were well experienced and well-educated youth and able to implement with efficient the Potatoes production technologies.

The training on agricultural extension technology did not reach to all the farmers in the area of study. However, those who received agricultural extension training on the technology implemented the technology on their farms.

Farmers in their farms in view of improving the Potato production applied safe and effective use of pesticides. Moreover, *Shangi* variety was mostly grown by farmers in the region and that farmers did not use the certified seed instead they sourced the seeds from other farmers. The reasons thereof were that the seeds were not available to them, expensive, they had no information and it was a new product to them. Besides, the farmers benefited from the use of technology as it improved the Potato yield, pest and disease control, input economics and improved market for Potato products.

The study recommends that there is need to improve on the training farmers on Potato productions technologies to improve on technology uptake and that farmers should be availed with certified seeds in view of improving the Potato production in the region.

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