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Socio - Economic Factors that Influence Adoption of Clean Seed Potato (*Solanum tuberosum*) by Small Scale Farmers in Njoro, Kenya

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Abstract
This study sought to determine the influence of selected social-economic factors on adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya. Clean seed potato is one of the best types of seed potato that farmers can use to increase potato productivity especially among resource-constrained farmers despite its low adoption. The objectives of this study were to determine the influence of selected social and economic factors on adoption of clean seed potato by small scale potato farmers in Njoro Sub-County. The findings of this study may guide extension service providers in formulating policies and interventions aimed at increasing adoption of high-quality seed potato for increased productivity. The study used a correlational research design. Data was collected in a cross-sectional survey. A researcher-administered questionnaire was used to collect data. The study used Chi-square test to examine the associations between selected socio-economic factors and adoption of clean seed potato at 5% level of significance. It was found out that the association between education level, belonging to farmer groups, and distance from the source of seed potato to the farms, and adoption of clean seed potato was significant ($p<0.05$). The study concludes that the level of formal education attained by farmers, belonging to farmer groups, and distance between the farms and the source of seed influences adoption of clean seed potato by small scale farmers in Njoro Sub-County. This study recommends that the government encourage farmers to form groups and train more farmers in commercial clean seed potato production in order to increase clean seed potato adoption for improved productivity, incomes and food and nutritional security.
Key Words: *Adoption; Clean Seed potato; Kenya; Potato; Small Scale Farmers*

1. Introduction

Potato (*Solanum tuberosum*) is a starchy tuberous crop and the world's fourth largest food crop after rice, wheat, and maize (Muthoni, Shimelis & Melis, 2013). It is a staple food for many families in East Africa, both in rural and urban areas. Potato favours the double cropping seasons common with the rain-fed systems in most African countries because it is a short cycle crop (3 to 4 months). As such, potato can be produced for up to three seasons a year hence improving food availability (Sanginga & Mbabu, 2015). In Kenya, potato is the second most important food crop after maize (Muthoni *et al*., 2013). It is grown on about 161,000 hectares of land with a production of close to 2-3 Million metric tons (MMT) worth Kenyan Shillings 40-50 billion annually at farm gate prices (Mumia, Muthomi, Narla, Nyongesa, & Olubayo, 2018). An estimated 800,000 farmers grow potato in Kenya, while over 3.3 million people are employed along its value chain as growers, traders, and processors (Okello, Zhou, Kwikiriza, Ogutu, Barker, Schulte-Geldermann, Atieno & Ahmed, 2016). About ninety seven (97%) of the potato farmers in Kenya, are small scale farmers owing to less than five acres of land devoted to potato production (Ministry of Agriculture, 2016). Consequently, potato contributes to poverty alleviation through income generation in both urban and rural households (Laibuni & Omiti, 2014).

Despite the potatoes' increasing importance in terms of consumption and income, its productivity in Kenya has stagnated in the previous years due to a number of factors (Ebrahim, Mohammed & Ayalew, 2018). For instance, most of Kenya´s potato production is dependent on landrace seed varieties, which farmers get from the previous harvests, neighbours, or from the open air markets (Taiy, Onyango, Nkurumwa & Ngetich, 2017). These varieties are degenerated with low yielding capacity, and infested with pests and diseases such as bacterial wilt and late bright. This leads to low yields and poor quality produce (Byarugaba, Namugga & Kashaija, 2013). Other factors that threaten potato productivity in Kenya include; use of poor quality seeds, pests and diseases, poor marketing systems, poor farming methods and poor post-harvest handling mechanisms among others (Schulte-Geldermann, 2012). According to Muthoni, Shimelis, and Melis (2013), diseases especially blight and bacterial wilt which are a major threat to potato production in Kenya, spread rapidly through use of farmer saved seed potato and inadequate rotation. This challenge could be solved through use of clean seed potato (Schulte-Geldermann, 2012).

Apart from climatic and agro ecological factors, the quality of seed potato used by the farmer is the major yield determinant (National Potato Council of Kenya 2017). There is insufficient supply and use of high-quality seed potato in Kenya. Despite its low adoption, clean seed potato also known as quality declared seed potato can increase productivity provided other good agricultural practices are adhered to (FAO, 2017). Clean seed potato is produced under the semi-formal seed system or the quality declared seed system (Kaguongo, Maingi, Barker, Nganga, & Guenthner, 2014). It is produced from certified seed and has the same qualities as certified seed potato for example; high yielding capacity and resilience to pests and diseases. However, it lacks inspection, sample testing and certification by the quality standards authority, for the case of Kenya its Kenya Plant Health Inspectorate Services(KEPHIS) thus making it less expensive than certified seed potato(Kaguongo, *et al.*, 2013). Trained farmers multiply it at farm level and is intended to bridge the gap for insufficient supply of certified quality seed to the farmers (Kaguongo *et al*., 2014). Productivity from clean seed potato is quite good as compared to farmer saved seed (Kaguongo, Ng'ang'a, Muthoka, Muthami, & Maingi, 2009).

Clean seed potato is one of the best types of seed potato that farmers can use to increase potato productivity especially among resource-constrained farmers. According to Kaguongo *et al*., (2014), clean seed potato is disease and drought resilient, matures faster and can increase potato yields by 30% through reducing disease incidences hence increasing farm productivity and incomes (Kamuyu, Muiru, Kimenju, & Nyongesa, 2017). Food and Agricultural Organization [FAO] (2017) reported that clean seed potato has been so instrumental in increasing potato yields in Ethiopia where 99 percent of the farmers used to rely on informal seed sources like the farmer saved seed and seed from the open markets. However the adoption of clean seed potato in Kenya is very low at only 1.4 percent (Kaguongo *et al*., (2014). In 2015, during a workshop organized by FAO in Rwanda on increasing access to high quality seed potato, the stakeholders recommended for increased production of clean seed potato because of increased competitiveness especially among small scale farmers (FAO, 2016). Observing the low use of clean seed potato, Kaguongo *et al*., (2014), also recommended for training of more framers in clean seed potato production.

Unlike certified seed, clean seed potato can be easily accessible and affordable to small scale farmers hence providing the best alternative to insufficient certified seed potato. Kaguongo *et al*., (2014) conducted a study on the value of seed potato from the different seed systems in ten major potato producing counties in Kenya, that includes; Nyandarua, Nakuru, Bomet, Kiambu, Nyeri, Meru, Nakuru, Narok, Mount Elgon, Taita Taveta, and Keiyo-Marakwet. They reported that only 1.4 percent of the respondents used clean seed potato while 1.1 percent of the respondents used certified seed potato whereas 96.4 percent of farmers used farmer saved seed. Another study by Gichuru and Dijk (2015), conducted on low potato yields in Kenya in the counties of Nyandarua, Meru and Nakuru- (Njoro and Kuresoi sub counties) reported that only 4.48 percent of the respondents used clean seed potato. This is despite the fact that clean seed potato increases yields, and can be easily accessed by the farmers.

Consequently, farmers continue to use farmer saved seed and seed bought from nearby markets and neighbours (Taiy *et al*., 2017). Farmer saved seed potato is obtained from the previous harvests and kept as planting materials for the next season (Kaguongo *et al.*, 2008). Most times this seed is highly degenerated with low yielding capacity (Mumia, Muthomi, Narla, Nyongesa, & Olubayo, 2018; Gildemacher, Schulte-geldermann & Borus, 2011).

The consistent use of farmer saved seed potato maintains productivity below the optimum. Average potato productivity in Kenya is about 7-10 tons per hectare compared to achievable 20 and 40 tons per hectare in Egypt and Netherlands respectively (Janssens, Wiersema, Goos, & Wiersma, 2013). In Nakuru County, potato productivity is generally low at about 14 tons per hectare though above the national average. The low yields lead to low incomes among farmers and reduces access to food thereby increasing food and nutritional insecurity. To increase income and

improve food security of potato farmers, there is a need to increase the yields, which can be achievable through use of high-quality seed.

While studies have been conducted to document the factors that influence small scale farmers' choice of seed potato, most of them focus on certified seed potato. These factors could be classified into social and economic factors. Social factors relate to culture, organizations and interactions that regulate access to and utilization of resources and services by people. They include access to extension services, membership in farmer organizations, farmer education level, age, gender, farming experience, government policies, and level of participation in programmes or projects (Dsouza *et al.,* 1993).

Economic factors are associated with improvement of welfare of the people through enhancement and advancement of production, investment, profitability and marketing capacity (Tey, 2013). These include distance from farms and the source of the seeds, farmers' income level, size of the farm land owned by famers, and access to credit services (Okello *et al*., 2016). Other economic factors such as use of credit in potato farming, farmer's off-farm income, and farm income of the farmer may influence farmers' choice of seed potato. The selected economic factors for this study were; major sources of income of farmers, estimated annual incomes, size of farmlands, and the distance from the source of seed to farms. These were selected because they have been found to influence adoption of agricultural innovations.

This study, sought to determine the influence of selected social-economic factors on adoption of clean seed potato by small scale farmers in Njoro Sub-County. The findings of this study may guide the ministry of Agriculture Livestock and Fisheries and other development partners in formulating appropriate policies, decisions, and intervention strategies aimed at increasing adoption of high-quality seed potato for increased productivity and food security.

2. Materials and Methods

The study was carried out in Njoro Sub-County of Nakuru County, Kenya, in June 2019. Njoro Sub County lies in the Mau escarpment at an altitude of 2100-2800m above sea level and receives an annual rainfall of 1600-2200 mm. This area receives a bimodal rainfall with long rains received between March to August while short rains are received from October to December. Maize and potatoes are the major crops grown in this area with agriculture being the main source of livelihoods for people in this area. Factors that have favoured potato production in this area include the rich volcanic soils, reliable rainfall, readily available labour force, and the availability of ready market for crop produce in both locality and the urban centers such as Nakuru, Nairobi, Naivasha, Gilgil, and Narok. These offer incentives for the potato sector to flourish.

The target population of the study was 34,062 small scale farmers in Njoro Sub-County. This study used correlational research design and data was collected in a cross-sectional survey. Simple random sampling technique was used to select 130 respondents who participated in the survey. Data was collected using a researcher-administered questionnaire containing closed ended dichotomous and polytomous questions as well as open-ended items. Prior to data collection, reliability of the questionnaire was determined through pilot testing with 33 small scale potato farmers from Lare Ward. Changes were made to the questions after piloting for ease of understand guided by the experience during piloting exercise. Cronbach's alpha reliability test, α was used to measure reliability which was accepted at a correlation coefficient of 0.7038 (≥.7).

Cleaned data was organized and coded according to study objectives and variables and was analyzed. Data analysis relied on descriptive statistics that included; percentages, frequencies, measures of central tendency and standard deviation, and, inferential statistics (Chi-square). Chi-square was used to examine the associations between socio-economic factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County at 5% level of significance.

3. Results and Discussions

3.1 Types of Seed Potato Used by small scale farmers in Njoro Sub -County

Only 35.4 percent of the respondents produce seed potato that they use and sell to the neighbours while over ahalf of the respondents (64.6%) did not produce seed potato. It was also found out that of those repondents who produce seed potato, only 12.5 percent of them produce clean seed potato while 87.5 percent produce positively selected seed potato. In this study, positively selected seed potato was included among the farmer saved seed potato because it is produced at farm level without supervision of any authorities. The study also sought to understand the types of seed potato used by respondents to produce ware potato. It was found out that over three quarters (81.5%) use the low quality farmer

saved seed potato, 11.5 percent use clean seed potato, 4.6 percent used certified seed potato while 2.3 percent buy their seed potato from open air markets and neighbours as shown Figure 1.

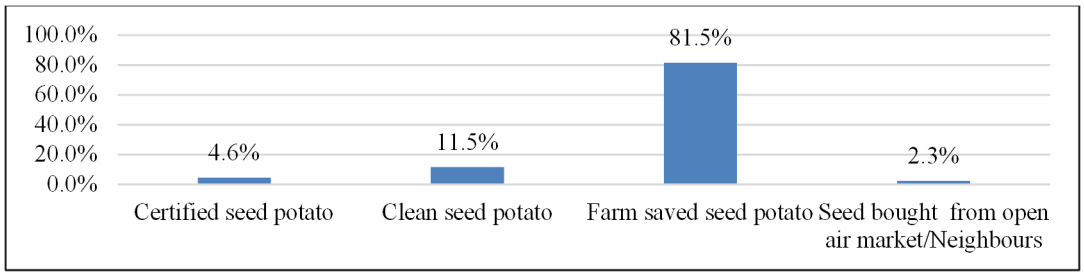

Figure 1: Types of Seed Potato Used by Respondents

These results confirm the problem of the study that there is low adoption of clean seed potato in Njoro Sub-County Kenya. These results agree with the finds of Kaguongo *et al.,* (2014), who found out that the farmer saved seeds are the most used by farmers in Nakuru County followed by clean seed potato, positively selected seed potato and certified seed potato being the least used. According to Kaguongo *et al.,* (2014), clean seed potato is not recognised for formal trade, a factor that may hinder its adoption despite its potential to reduce pest and disease incedences hence increasing yields. The farmer saved seed potato is degenerated, infested with pests and diseases with a low yielding capacity.

3.2 Adoption of Clean Seed Potato in Njoro Sub-County

The study sought to describe the adoption of clean seed potato in Njoro Sub County. Two categories were created from respondents that is adoptors and non adopters. Respondents who planted using clean seed potato consistently for three or two times in the previous three planting seasons were termed as adoptors while those respondents who used cean seed potato once or none were termed as non adoptors. Only 12 percent of the rsponents were considered as adoptors of clean seed potato while, over three quarters (88%) were termed non adoptors of clean seed potato as shown in Figure 2.

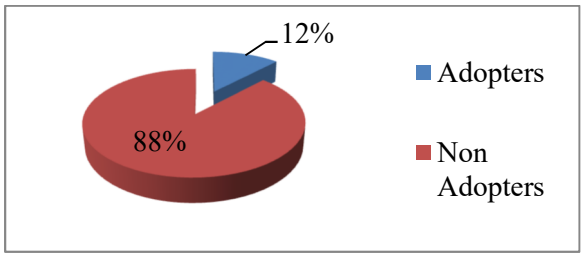

Figure 2: Adopters and Non-Adopters of Clean Seed Potato

3.3 Association between Selected Social Factors and Adoption of Clean Seed Potato in Njoro Sub-County

The association between selected social factors and adoption of clean seed potato is presented in Table 1. The selected social factors were; household size, experience, age, gender, education level completed, and belonging to farmer groups. These factors have been found to influence adoption of agricultural innovations(Kiplagat, Rehema, Xianli, Mchomvu, Baloch, 2016; Okello *et al*., 2016; Sulo, Koech, Chumo, & Chepng'eno, 2012).

Table1: Chi Square Test Results for Association between Selected Social Factors and Adoption of Clean Seed Potato

Scale	χ^2Value	df	P.value
Household size	2.170	2	.338
Experience	10.508	7	.162
Age	5.222	6	.516
Gender	.129	1	.720
Highest level of education completed	8.596	3	.035*
Respondent belonging to a potato farmer group	4.665	1	.031*
N=130			

There was a statistically significant association between highest level of education completed, belonging to potato farmer groups, and adoption of clean seed potato by respondents at 0.05 significance level, [(education χ^2 (3, N = 130) = 8.596), (belonging to potato farmer group χ^2 (1, N = 130) = 4.665)] p <0.05.

There was a statistically significant association between belonging to farmer group and adoption of clean seed potato in Njoro Sub-County at 0.05 level of significance. Indeed, of the respondents who were adopters of clean seed potato, 75 percent of them belonged to farmer groups while only 25 percent did not belong to farmer groups. There was a positive but non-significant relationship between belonging to farmer groups and adoption of clean seed potato at 0.05 level of significance [r (13) = 0.75, P=.789].These results are consistent with the findings of Mmbando & Baiyegunhi, (2017), who concluded that farmers who are members of farmer groups/associations are two times more likely to adopt improved maize varieties compared to their counterparts who do not belong to farmer groups. These findings also agree with those of Sulo *et al*. (2012), who found out that belonging to farmers groups favourably influences farmers to adopt agricultural technologies including improved high yielding varieties like the clean seed potato. This they argued is due to reduced cost of inputs due to collective group action. This suggests that belonging to farmer groups might influence farmers to adopt clean seed potato in Njoro Sub-County. However, this result disagrees with the findings of Kiplagat, Rehema, Xianli, Mchomvu, & Baloch, (2016), who found out that belonging to a farmer group or association was not significant in influencing potato farmers to adopt clean certified seed potato in Baringo County Kenya.

Equally, there was a statistically significant association between formal education level completed by respondents and adoption of clean seed potato at 0.05 confidence level. It was observed that all those respondents who use clean seed potato, have at least completed primary level of education. More than three quarters (86.7%) of the respondents who had adopted clean seed potato had attained primary and secondary education levels while only 13.3 percent only had a University/college education. This study further revealed a positive and significant correlation between education level completed by the respondents and adoption of clean seed potato [r (129) =.183, P=.037]. These results agree with those of Mmbando & Baiyegunhi, (2017), who found out that increasing number of years of education by the farmer statistically and significantly influenced maize farmers in Hai district of Tanzania to adopt improved maize varieties. Deepa *et al*., (2015) & Ahmed, (2015), also found education to have a positive influence on farmers in adopting new agricultural technologies especially in developing countries.

The association between household size, experience, gender, age, and adoption of clean seed potato was not statistically significant at 0.05 level of significance, [age χ^2 (6, N = 130) = 5.222), (household size χ^2 (2, N = 130) = 2.170), (experience χ^2 (7, N = 130) = 10.508), (gender χ^2 (1, N = 130) = .129), p > .05.

3.4 Association between Selected Economic Factors and Adoption of Clean Seed Potato in Njoro Sub-County

The association between selected economic factors and adoption of clean seed potato is presented in Table 2. The selected economic factors were; Sources of income of respondents, size of farmland land owned by respondents, income of the respondents and distance to the source of seed potato from farms. These factors have been found to influence adoption of agricultural innovations like the certified seed potato.

Table 2: Association between Selected Economic Factors and Adoption of Clean Seed Potato

Scale	χ^2 Value	Df	P value
Sources of income	2.311	3	0.510
Size of land owned	9.007	6	0.173
Income of the farmer	6.894	4	0.142
Distance to the source of seed	39.502	4	0.000***
n=130			

The association between distance to the farms and source of seed, and adoption of clean seed potato was statistically significant at 0.05 level of significance, χ^2 (4, n = 130) = 39.502, p <0.05.Indeed spearman's correlation test results between distance to the source of seed and farms, and adoption of clean seed potato revealed a statistically significant positive relationship [r (129) =.433, P=.000]. Results revealed that 86.7% of the respondents who use clean seed potato, their farms are located less than 10 kilometers away from the sources of the seed. This indicates that the longer distance between the source of seed and the farms reduces the likelihood of the farmer from adopting clean seed potato. These findings agree with those of Kiplagat *et al.,* (2016), who concluded that the distance between the

farmers' farms and the source of the seeds influences the decision of the farmer to adopt certified seed potato. This is true because Burke *et al.,* (2015) found out that farmers located far away from the input markets are less likely to adopt such inputs due to increased transactional costs

The association between source of income, income, size of farmland owned, and adoption of clean seed potato was not statistically significant at 0.05 level of significance, [(sources of income χ^2 (3, N = 130) = 2.311), (income χ^2 (4, N = 130) = 6.894), (size of land owned χ^2 (6, N = 130) = 9.007)] $p > .05$.

4. Conclusions and Recommendations

This study concluded that the level of formal education attained, belonging to farmer groups and distance between the farms and the source of seeds influences adoption of clean seed potato among small scale potato farmers in Njoro Sub-County, Kenya.

The study therefore recommends that policies be put in place that aims at improving literacy rates. In addition, the study also recommends training of more farmers in commercial clean seed potato production. This will reduce the distances traveled by farmers in search of seed potato and hence might increase adoption of clean seed potato. The study also recommends that agricultural extension officers help farmers to form groups for collective action. Belonging to farmer groups might help farmers to adopt agricultural innovations like the clean seed potato that may help them improve productivity and enhance their standards of living.

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