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Agricultural Training Centres' Contribution in Promoting Food Security among Smallholder Potato Farmers in Nyandarua County, Kenya

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***Abstract* – The agriculture sector contributes significantly towards world economic growth and is a source of livelihood for most people living in rural areas. Food security can be achieved through increased agricultural production and productivity. Small-scale farmers are trained at the Agricultural Training Centres (ATCs) on crop production techniques aimed at increasing crop production and productivity, using a formal curriculum. However, the effectiveness of ATCs' curriculum in promoting adoption of crop production technologies is not well documented. Consequently, the contribution of ATCs in achieving food security in Nyandarua County is not known. This study was therefore done to document the effectiveness of ATCs' curriculum in promoting farmers' adoption of selected potato technologies in Nyandarua County. A survey was done to collect primary data from 136 farmers trained at ATCs on potato production, using interview schedules and sampled through a five stage technique. The data was analyzed using ANOVA and summarized using percentages. Results showed that adoption of recommended potato production technologies produced higher yields. It was therefore concluded that ATCs contributed significantly to the achievement of food security in Nyandarua County. This was based on the higher yields obtained by the potato farmers who had adopted potato selection, planting, and crop protection and harvesting technologies after being trained at the ATCs on potato production. The findings of this study can be used by the ministry of agriculture in formulating policies for guiding farmer training at ATCs. The ATC administrators can also use the results in identifying gaps in the curriculum with an aim of improving it.**

***Keywords* – Agricultural Training Centre, Curriculum, Adoption, Effectiveness.**

I. INTRODUCTION

Agriculture contributes about 3% of global Gross Domestic Product and employs more than two billion people in the world [28]. Most of the world's poor people are farmers and a growth in agricultural GDP is effective in poverty reduction than growth from other economic sectors [21], [28]. Agriculture also provides good opportunities for rural economic development in most Sub-Saharan African countries [31]. Agricultural-based economic growth has a stronger effect on economic growth than non-agricultural growth besides significantly contributing towards the achievement of Millennium Development Goals [24]. About 80% of Kenyans live in rural areas and depend on agriculture either directly or indirectly for their livelihoods [25]. In Kenya, the agriculture sector contributes about 24% of the total Gross Domestic Product (GDP) and 19% of formal employment [25], [26]. Further, about 60% of all households in Kenya are engaged in agricultural activities and the national agriculture policies aim to transform the sector into an innovative, competitive, commercial, and modern industry [26]. This will improve food security and equity in rural and urban areas. Since agriculture contributes about 26% and 25% of GDP directly and indirectly, respectively, it is the backbone of Kenya's economy, [25]. It further contributes about 65% of total exports and 18% of formal employment respectively. About 75% of farming in Kenya is commercial and small-scale on land size ranging from 2-3 ha [25].

Reference [20] and [75] define food security as the condition when all people at all times have physical and socio-economic access to enough, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. This means that a food insecurity situation exists when all people are unable to secure an adequate diet today, and are at the risk of being unable to secure adequate diets in future [29], [13]. For food security to be achieved, food has to be available, accessible and adequate [75]. Food availability refers to the supply of food which is sufficient in quantity, quality and provides variety [52]. On the other hand, food access addresses the demand for food and is influenced by economic factors, physical infrastructure and consumer preferences [60]. Therefore, for households and individuals to be food secure, the food they access must be adequate in quantity and quality, and ensures adequate, consistent and dependable supply of energy and nutrients through affordable and socio-culturally acceptable sources at all times [62], [11]. Ultimately, food security translates to active and healthy life for every individual.

Agricultural productivity and production is the bedrock of food security in Sub-Saharan Africa because it influences food availability [75]. Furthermore, growth in agricultural productivity can generate farm employment and income especially for small-holder farmers. Agriculture provides income and employment for Africans especially the poor [62]. The agriculture sector being the largest employer in developing countries, its growth significantly reduces poverty, increases income generation for the poor while reducing food prices [6]. More so, most people who work in agriculture live in rural areas which are characterized by poverty. Reference [46] observed that there are about 500 million small-holder farms in the

world, supporting about 2 billion (30%) of the world's population. Reference [46] adds that small-holder farmers manage about 80% of Africa's and Asia's farmland, and produces 80% of the developing world's food consumption. About 75% of Africa's people live in rural areas and rely on agriculture as their major source of livelihood [6]. To improve the national and household food security, small-holder farming must be transformed from subsistence to a market-oriented production [6]. Therefore, raising agricultural productivity can sustainably improve food security in Africa and consequently increase farm food supplies [6], [62]. Reference [30] emphasizes that agriculture is the key socio-economic sub-sector for assuring food security in developing countries. For instance, in the year 2010, the agriculture sector in Kenya grew at 6.3% from negative 2.9% in 2009 [39]. Consequently, the national GDP grew to 5.6% from 2.6% in the same period.

Reference [21] reported that about 870 million people (12.5%) in the world were undernourished between 2010 and 2012, with 852 million living in developing countries (14.9%). Reference [77] and [59] also found that about 30% (239 million) of the Africa's total population of the world's total of 1 billion undernourished people live in Africa. This results from low food and agricultural productivity and production, poverty, land degradation, climate variability and change, high population growth, rapid urbanization, volatile food and fuel prices [4], [77] and [59]. Reference [60] further established that over 70% of the food insecure people in Africa live in rural areas while [62] observed that food insecurity in Africa results from constrained food production, insufficient production, high import prices, rapid population growth and rapid urbanization. On the other hand, reference [34] reported that food insecurity in Sub-Saharan Africa results from the effects of climate change, HIV/AIDS, environmental degradation, conflicts, rapid population increase, poor governance and the decline in public services especially education and health. Reference [37] and [62] add that food insecurity in East Africa results from low harvests, high food prices, conflicts and insecurity, inadequate post-harvest services and drought. This was attributed to the sharp decline in cereal and pasture production in 2011. Reference [59] also attributed the low food access in the East African countries in 2012 due to high global food prices except for rice, reduced local production, and decline in household income.

World cereal production was expected to increase by about 3.2% in 2012 (2.419 million tonnes) including Africa although food security for African people would not improve unless they accessed the food [20]. Reference [33] observed that the horn of Africa (Somalia, Kenya, Ethiopia, Djibouti) faced a serious food and nutrition crisis in terms of scale and severity. This was shown by the more than 13million people in the horn and East Africa who needed food aid. Further, in East Africa including Kenya, Djibouti, Somalia Ethiopia, food availability situation did not improve despite the increase in cereal production. Consequently Africa imported about 43 million tonnes of food in 2011 [20]. Insufficient food production in Kenya caused food deficits over successive years [73]. Furthermore, maize is the staple food in Kenya and its deficit is considered synonymous with food insecurity. Maize deficits in Kenya were up to 35% below the annual average production in 2011, necessitating imports despite the cereal prices being 50-80% higher than the 5-year national averages [27]. Reference [73] and [27] established that food insecurity in Kenya is caused by various factors such as high commodity prices, endemic livestock diseases and parasites, civil insecurity and conflict, poor weather conditions, human-wildlife conflict, environmental degradation, climate change, institutional and governance issues, illiteracy and poor infrastructure. Reference [66] also found that in Nyandarua County, the main staple foods are potatoes and maize mixed with beans. This means that a scarcity of these foods especially during planting seasons results in a decline in household food security.

1.1. Agricultural Extension as a Form of Education

Agricultural extension dates back to the early 1900s [79]). In Kenya, the bulk of agricultural extension is provided by government extension workers although currently private companies also provide extension services [7], [74], [52], [15]. Reference [1] defines agricultural extension as a system for transferring skills between farmers, extension workers and researchers aimed at promoting adoption of technologies. The information disseminated may be in form of advice, skills and education which promotes food security, wealth and employment creation and poverty reduction [52] and [5]. Reference [70] and [47] conceive agricultural extension as a form of non-formal education aimed at improving agricultural yield. On the other hand, [49] holds the view that extension is an educational process which involves teaching and learning aimed at creating desired changes in people. Furthermore, it solves farmers' problems and serves as a bridge between researchers and farmers [48]. Through education, communities get empowered while individuals gain skills and become productive, translating into a successful agricultural sector [65]. Reference [7] emphasizes that adoption of agricultural technologies can be influenced by farmer education.

Reference [52] explains that most of the public agricultural extension in Kenya is provided by extension workers in the field, at Agricultural Training Centres (ATCs) and parastatals like Horticultural Crops Development Authority, and National Cereals and Produce Board. Farmer Training Centres are found in different countries in the world such as Ethiopia [49], Kenya, Tanzania, Turkey, India and Namibia [64]. There are 28 ATCs in Kenya distributed in different geographical locations with two (Oljoro Orok & Njabini) in Nyandarua County [56]. The ATCs were formed in 1950s in Kenya to promote high yielding technologies and serve as the primary learning and testing centre [64]. The ATCs were 11 in 1968 but progressively increased to 28 by 2011 [57]. Reference [50] reported that although the ATCs used *ad hoc* training programmes since their formation up to 2006, currently formal curricula are used. Reference [51] also established that in crop husbandry the curriculum content

includes seed selection, and fertilizer application, crop protection, planting and thinning. Additionally, for potatoes, it also includes harvesting, storage and processing. Reference [24] considers potatoes to have the potential to significantly contribute to poverty reduction; improved food security and rural economic development, since majority of the producers are small-scale farmers.

Reference [12], [18] and [34] established that the potato originated from Andean Cordillera and spread to other parts of the world in the 15th century, and [18] found that it spread to Africa in the 20th century. Reference [32] considers potato as the world's third most important food crop after rice and wheat, and in Kenya it is the second most important food crop after maize and is grown by small-holder farmers [2], [9], [35]. In tropical countries the crop is grown in altitudes of 1200-1300m [18] while in Kenya it is produced in altitudes of 1500-3000m which include Nyandarua, Nyeri, Thika, and Muranga districts [45], [78]. Kenya's production constitutes about 6.5% of Africa's total production [63]. Potato yields in Kenya are low due to inadequate use of certified seed, crop protection and poor husbandry practices [16], [55]. Consequently, yields in Kenya are as low as 8ton/ha compared to the world's average of 16.8ton/ha [17], [34].

Africa is the third (7%) potato producer in the world after Asia (48%) and Europe (33%) while China leads in the world with 20% of the global production [34]. In Africa, Malawi led in potato production with 20% of the total production in 2007 [34], [22]. In 2007, the world's average potato production was 16.8ton/ha, Africa's 10.8ton/ha, Malawi's 11.9ton/ha while Kenya had 6.7ton/ha [34]. Kenya was 5th largest potato producer in Africa in 2009, by producing 1,679,688 ton [34]. Potato is a major food and cash crop in Nyandarua County [58]. Nyandarua County is a major potato producing area in Kenya whereby it produced 18.4% and 42% of the total production in 2009 and 2011 respectively [53], [56]. However, potato yields in Nyandarua County range between 8 to14 ton/ha against a national average of 24 ton/ha and potential of 30ton/ha [57]. Extension workers train farmers on basic crop production technologies [64]. Reference [7] explains that farmer education influences adoption of crop production techniques. Potato farmers in Nyandarua County are trained at ATCs on crop production are therefore expected to adopt the technologies. This can increase yields obtained by the small-holder farmers.

Despite the existence of two Agricultural Training Centres in Nyandarua County out of the 28 found in Kenya, small-scale potato farmers obtain low yields as low as 8ton/ha against a national average of 24ton/ha and potential of 30ton/ha. The information available about the effectiveness of ATCs' curriculum in promoting adoption of crop production technologies is low or poorly documented. This necessitated a study to establish the influence of ATCs' curriculum on potato farmers' adoption of production technologies after being trained at ATCs. Adoption of recommended crop production technologies can increase yields and contribute to food security in the County. Adoption of potato technologies can increase yields obtained by small-scale potato farmers, increase food availability and therefore increase household food accessibility. The information generated by this study will help in identifying technology gaps in ATCs' curriculum that could affect potato production in Nyandarua County. It can also be used by extension experts to design extension models for ATCs. The study involved small-scale potato farmers trained on potato production at ATCs in Nyandarua County.

1.2. Theoretical Framework

This study was guided by the constructivist and behaviorist theories of learning. The term constructivism refers to a learning situation where learners are actively engaged during learning and are able to create rather than passively acquire knowledge [69]. A trainer provides learners with opportunities and activities which allow them to experiment and manipulate objects in the learning environment independently. Reference [42] explains that this theory emphasizes authentic tasks, problem solving and understanding where the teacher guides, coaches and facilitates the learning process. For successful learning, the learning situations, environments, content and tasks must be relevant, realistic and represent the natural complexities of the real world [42], [69]. Since learners get motivated when they are actively involved in activities they consider useful in their lives, teachers should create situations that allow learners to form their own understanding [68]. On the other hand behaviorists regard behavior as a response to stimuli and argue that people's behavior is controlled by their environment and prior learning [71]. Reference [68] argues that behaviorists define learning as a change in behavior that results from a stimulus-response association made by the learner. They add that a learner selects one response from many because of prior experience and psychological drive prevailing at a particular moment.

Reference [3] argues that pleasant things have a strengthening effect on human behavior. The classical conditioning learning theory developed by Watson, argues that human development should be based on the observation of external behaviors and not speculation on the sub-conscious motives [72]. Behaviorists believe that behavioral changes in human beings occur for a reason they attributed to the liking of learners to work on things that bring them positive feelings, change behavior to satisfy the desires they have learnt to value and avoid those they associate with unpleasant consequences [71], [68]. Reference [68] adds that teachers who use the behaviorist learning techniques break down the subject matter into basics and present it to learners systematically at different stages. The learners who are exposed to these learning experiences change and develop behaviors that may be repeated more often [3]. This means that if the potato farmers are actively involved in tasks they consider useful in farming, they will voluntarily adopt the subject matter in the Agricultural Training Centre's curriculum presented systematically, thus improve yields. The independent variable in this study was Agricultural Training Centres' farmer training curriculum while the dependent variable was the effectiveness of the ATCs' training curriculum. The effectiveness of the ATCs' curriculum was measured in terms of the percentage of the

potato farmers trained at the ATCs on potato production and had adopted the recommended production technologies.

II. Research Methodology

This study used a descriptive design involving a sociological survey using descriptive statistics. Characteristics of farmers trained at the Agricultural Training Centres (ATCs) in Nyandarua County were described and the frequency of the occurrence of various variables and their relationship with the dependent variable determined, as recommended by [36] and [37]. The study was conducted in Nyandarua County, situated in Central Kenya and is one of the major potato growing regions in Kenya [53] and is served by two ATCs (Njabini and Oljoro Orok). The County is 3,528km^2 in size out of which 2,100km^2 is arable land [14]. Potato is a major vegetable produced in Kenya, and its production is a main economic activity in Nyandarua County [5]. About 82% of Nyandarua County's total population of 596, 268 persons live in the rural areas [38]. While majority of the farmers in Nyandarua County practice subsistence mixed farming on 0.08 to 2 ha of land, their main source of livelihood is potato production [38]). Potato growing seasons in Kenya depend on rainfall patterns, which occur in February-June and October- December [78], [58], including in Nyandarua County.

Farmers visit the ATCs in the County for training on crop and livestock production technologies, including potato production. A five-stage sampling design was used to select respondents for this study. It involved progressive selection of smaller clusters of the sample until individual members of the sample were selected [67]. The sample of farmers was determined using a formula for estimating the sample size from a given population as recommended by [36]. The sampling units were the individual small-scale potato farmers in Nyandarua County. The initial sample size of 113 respondents chosen was adjusted upwards by 20% as recommended by [10], yielding a sample size of 136 respondents who were involved in the study. An interview schedule developed by the researcher was used to collect primary data from small-scale potato farmers trained at the ATCs in Nyandarua County on potato production. Secondary data was collected through document reviews.

Primary data was collected on seed selection, planting, crop protection, and harvesting practices among small-scale potato farmers trained at the Agricultural Training Centres (ATCs) in Nyandarua County. The interview schedules were validated through built-in validation items and discussions with agricultural education and extension experts in Egerton University. Reliability of the interview schedules was achieved through pilot-testing in Kieni East district using thirty small-scale potato farmers trained at Wambugu ATC on potato production. A Cronbach's alpha procedure was used to establish the instrument's internal consistency while a reliability coefficient of 0.86 was accepted. This was because it was above the minimum accepted of 0.7, at a confidence level of 0.05, set *apriori* [23], [61].

III. Results and Discussion

The study established that more males (66%) are engaged in potato production than females (34%) in Nyandarua County as shown in Table. Unlike men who participate in most farmer trainings and do not provide farm labor; women provide most of farm labor although they participate in little training. This concurs with [41] and [6], who argue that women provide 75% of agricultural labor although men are the greatest beneficiaries of extension services. Reference [20] adds that women involved in agriculture are constrained by limited access to extension services. About 30% of farmers in Nyandarua County were less than 40 years of age, 63% were 41-60 years while 7% were aged above 60 years as shown in Table 1. This showed that more adults aged 40 years and above are engaged in potato production unlike most youth and adults aged below 40 years (63%). This could imply that agriculture in Nyandarua County is dominated by an aging population, which may result in reduced agricultural production. Since males dominate farmer trainings and females provide most of farm labor while the population providing farm labor is aging, the skills acquired during ATCs' training may not significantly increase potato yields.

About 83% of potato farmers in Nyandarua County have either primary or secondary education with 12% having tertiary, 2% university and only 3% having no formal education as shown in Table 1. This means that most (96%) farmers in Nyandarua County are literate. Involvement of literate farmers in training increases their understanding of the subject matter and may increase adoption of technologies. The study further found that potato farmers in the Nyandarua County produce the crop for sale and home consumption. This agrees with the findings by reference [8] who had established that in Sub-Saharan Africa, potatoes are grown for sale and for home consumption. Reference [2] also indicated that in Kenya potatoes are grown as a food and cash crop. It also concurs with reference [66], who found that the main staple food crops in Nyandarua County are potatoes and maize. This means that potato production significantly contributes to food availability and ultimately food security in Nyandarua County. This justifies the need for farmer training at ATCs on technologies aimed at increasing potato yields.

Table 1: Gender, Age and Education Level of Potato Farmers in Nyandarua County

Variable	Percent
Gender	
Male farmers (n=90)	66
Female farmers (n=46)	34
Age (years)	
Farmers aged 40≤ (n=41)	30
Farmers aged ≥41 (n=95)	70
Education level	
Farmers who attained at least primary education (n=132)	97
Farmers who had no formal schooling (n=4)	3

3.1 Potato Seed Selection Technologies

During potato production training at ATCs, farmers learnt potato seed selection technologies including use of certified seed, characteristics of clean seed, source of clean seed, potato seed size and minimum sprouts per tuber seed. This study established that about 85% of potato farmers knew the correct seed size while 70% knew the correct number of sprouts per seed tuber. A further 96% knew characteristics of 'clean' potato seed. The results also showed that farmers who adopted the seed selection technologies obtained a yield of 19ton/ha while those who had not adopted obtained 13ton/ha. This means that farmers trained at the ATCs can select clean potato seed of correct size and with correct number of sprouts after being trained at ATCs. However, 47% of the farmers obtained seed from their farms, 24% from farmer groups, 14% ATCs, 9% Kenya Agricultural Research Institute (KARI), 4% other farmers and 2% from Molo Agricultural Development Corporation (ADC), as shown in Fig. 1. This shows that despite farmers' good knowledge of potato seed selection technologies, majority (75%) do not use certified or clean seed as recommended during trainings on potato production. This is against [40] who recommend the use of certified seed when planting potatoes. Reference [43] attributes the failure to use certified seeds by farmers to inadequate availability of potato seed. Potato yields can be increased by selecting potato seed as recommended during farmer training.

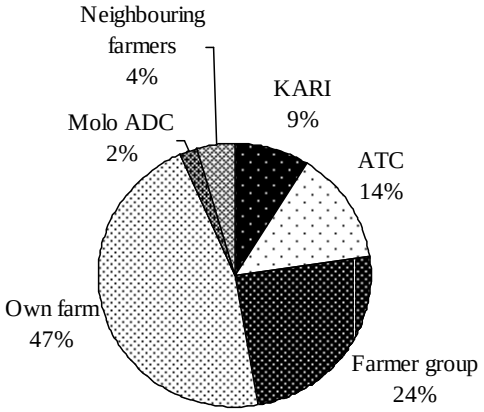

Fig.1. Sources of potato seed

3.2 Crop Protection Technologies

Potato farmers were trained at ATCs on sources and use of clean or certified seed, crop rotation and the role of volunteer crops in potato crop protection. Results of this study showed that although 96% of the potato farmers understood clean potato seed as being disease-free, up to 69% of them use volunteer crop as food while 89% practise crop rotation. The results also showed that farmers who adopted crop protection technologies obtained a yield of 17ton/ha while those who had not adopted obtained 13ton/ha. This means that majority of potato farmers were knowledgeable on potato weed, pest and disease control after being trained at ATCs on potato production. In contrast, majority of the farmers did not use potato seed from recommended sources and also do eat the volunteer crop (Figure 1). This implies that most farmers do not practice recommended crop protection technologies. The results therefore agree with [24] who argues that only 1% of potato farmers in Kenya use clean potato seed. Reference [24] advises that the use of uncertified potato seed significantly reduces yields because diseases like bacterial wilt cause losses of up to 75%. Reference [66] had also established that most potato farmers recycle already infected seed tubers they obtain from neighbors. Failure to use seed from certified sources creates difficulties in controlling potato pests, diseases and weeds. This concurs with [78] who observed that majority of farmers in Nyandarua County do not use certified or clean potato seed. This is supported by [43] who found that farmers' use of previous potato crop, buying from local markets or neighbors' increases disease build up and spread. These observations were supported by [16], who explained that failure to practise crop rotation by farmers increase disease incidences, resulting in yield decline. Reference [24] advises that use of clean potato seed and crop rotation helps in controlling potato weeds, pests and diseases.

Table 2: Farmers' Knowledge of Clean Potato Seed, Use of Volunteer Crop and Crop Rotation

Variable	Percent
Clean potato seed	
Farmers who understand clean potato seed as being 'disease-free' (n=131)	96
Farmers who understand 'clean' potato seed as being 'free from dirt' (n=5)	4
Use of volunteer potato crop	
Farmers who eat volunteer crop (n=94)	69
Farmers who sell volunteer crop (n=22)	16
Farmers who use volunteer crop as fodder (n=7)	5
Farmers who do not use volunteer crop in any way (n=14)	10
Crop rotation	
Farmers who practice crop rotation (n=121)	89
Farmers who do not practice crop rotation (n=15)	11

3.3 Potato Planting Technologies

Potato planting technologies include correct planting method, use of correct type and amount of fertilizer and correct spacing. Results of this study showed that 69% and 54% of potato farmers use correct spacing within and between rows respectively while 96% prepare ridges, 96% use correct type of fertilizer while only 58% use correct fertilizer rates. The results also showed that farmers who had adopted the planting technologies obtained 17ton/ha while those who had not adopted obtained 13ton/ha. This means that most potato farmers in Nyandarua County use the recommended planting technologies after being trained at ATCs. This is supported by [78] who established that 82% of farmers in Nyandarua County use fertilizer for crop production and [22] who recommends Di-Ammonium Phosphate fertilizer for planting potatoes. Reference [24] and [66] argue that the use of correct fertilizer rates increases potato yields. If correct spacing, fertilizer type and amounts are used during planting, a healthy crop of correct population per unit area will be

produced. This may produce high yields. Ridging and earthing up helps to control pest and diseases and also induces tuber formation. This significantly increases the quality and quantity of potato yields.

Table 3: Potato Spacing, Ridging, and Fertilizer Application by Farmers in Nyandarua County

Variable	Percent
Farmers using recommended spacing within rows (n=94)	69
Farmers using recommended spacing between rows (n=73)	54
Farmers who practice ridging (n=131)	96
Farmers using recommended fertilizer rates (n=79)	58
Farmers using recommended fertilizer type (n=131)	96

3.4 Potato Harvesting Technologies

Potato harvesting technologies include indicators of potato maturity, recommended harvesting method, method and timing of dehaulming before harvesting potatoes. Results showed that in determining potato maturity, approximately 57% of the farmers check whether the plant is dry, 14% check if flowers have dropped, 23% if the plant has turned yellow, 3% if the skin of tuber has hardened while 3% use the age (days after planting) as shown in Table 4. A further 67% dehaulm potatoes while 79% use correct methods of harvesting potatoes. This implies that most potato farmers practiced recommended potato harvesting technologies after being trained at ATCs on potato production. The results also showed that farmers who had adopted the harvesting technologies obtained 17ton/ha while those who had not adopted obtained 14ton/ha. This agrees with [22] recommendation that potatoes should be harvested when stalks are dry and dehaulmed 2-3 weeks earlier before harvesting [40]. Correct diagnosis and interpretation of potato maturity indicators by farmers can significantly affect yields. This is because some maturity indicators resemble pest and disease manifestation or malnutrition such as yellowing or drying of plant and falling of flowers. Potato farmers therefore need to be skilled in distinguishing between disease manifestation and a mature potato indicator for the commonly grown potato varieties. Mature potato tubers have high dry matter content and are high in quality. Further, farmers need to prepare for harvesting by dehaulming their crop using correct method at the right time. Harvesting at the right stage of maturity and dehaulming can increase potato yields.

Table 4: Adoption of Potato Dehaulming and Maturity Indicators by Potato Farmers in Nyandarua County

Variable	Percent
Dehaulming	
Farmers who do not dehaulm potatoes (n=45)	33
Farmers who dehaulm potatoes (n=91)	67
Potato maturity indicators	
Farmers who check if the plant is dry (n=78)	57
Farmers who check if flowers have dropped (n=19)	14
Farmers who check if plant is yellow/ brown (n=31)	23
Farmers who check if tuber skin is hard (n=4)	3
Farmers who use age of crop plant since planting time (n=4)	3

3.5 Sources of Agricultural Information for Potato Farmers

A comparison of different sources of agricultural information for potato farmers showed that about 83% consider Agricultural Training Centres (ATCs) to be better sources of information than other sources. Among the other sources of information, 56% of farmers regard radios as important, 53% public extension workers, 50% field days, 29% fellow farmers, 16% mobile phones, 7% television and 3% internet services (Fig. 2). More farmers reported that they obtain agricultural information from ATCs than other sources. This could be attributed to the systematic delivery of the subject matter and the likelihood of completing the curriculum content during training at ATCs. Further, more farmers reported that they obtain agricultural information from radios than from extension agents. This may mean that almost every household has a radio to which members listen agricultural programs more often than they meet extension agents, than they attend field days, meet their fellow farmers, use mobile phones, watch televisions or use the internet. The percentage of farmers obtaining agricultural information from radios could be higher probably because radio programs normally run on specific times and days which farmers can avail themselves to listen. This contrasts meeting with the extension agents, field days or fellow farmers which a farmer may not definitely predict when they will take place. Further, some farmers have no mobile phone, television or are incompetent to use them to obtain agricultural information. They therefore prefer ATCs to other sources.

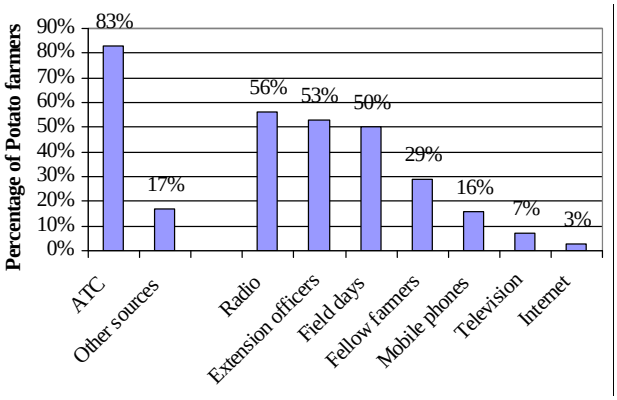

Fig.2. Sources of agricultural information

This study concluded that Agricultural Training Centres' (ATC) curriculum is effective in promoting small-scale potato farmers' adoption of potato seed selection, crop protection, planting and harvesting technologies after being trained at ATCs on potato production. Adoption of recommended potato production technologies promoted by ATCs' curriculum increases

potato yields among small-scale farmers. This shows that ATCs can significantly contribute to an increase in food availability and ultimately food security in Nyandarua County.

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