Original Research Article

Perception on Access and Use of Modern Information Communication Technologies in Enhancing Smallholder Tea Production inKakamega County, Kenya

AbstractThe smallholder tea sector in Kenya forms the second-largest agricultural exporter after horticulture, contributing 4 percent to the Gross Domestic Product (GDP). Modern communication technologies (MCTS) are key in supporting production, processing and marketing across the tea sector value chain. Despite the availability of all these technologies, their access and use by smallholder tea farmers for production and tea auction price monitoring are still minimal. Further, farmers' perception on access and use of modern communication technologies is not well known. The objective of this study was to evaluate smallholder farmers' perceptions on access and use of modern communication technologies in enhancing tea production in Shinyalusubcounty.The study was anchored on diffusion of innovation that emphasizes on the five attributes of an innovation. The study evaluated the farmers' perception of access and use of MCTs. The study adopted a descriptive research design where fisher's formula was used to get 162 out of 1,600 smallholder tea farmers who were systematically sampled and interviewed. Data was collected using semi-structured questionnaires and a Likert perception test scale. The data was cleaned and analyzed using SPSS, and results were presented in tables and graphs. The results established that majority(36%) of the tea farmers had acquired basic literacy levels of education to use modern technologies in tea production. It also established that modern technologies such as smartcard technology 78%, mobile phone text messages 62% and personal digital assistants 61% were the most essential tools for enhancing access to farm inputs, market information and tea management information. However, extension agents 61% played a complementary role in unpacking and linking modern tea technologies from the source to farmers. A positive association was revealed between farmers' literacy level and the use of MCTs, which influenced access to MCT.The study, recommended re-tooling agricultural information dissemination agents and farmers on the existing MCT to enhance effective communication, promoting tea production yields and accessing market information.

KeywordsInformation,Modern Communication Technologies, MCTs, Perceptions,Production,Smallholder

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Introduction

Agriculture is notable as key to Kenya's economy, but there exist low agricultural production in many parts of the country despite the available production technologies. This could be attributed to ineffective smallholder extension services and information asymmetry among farmers (FAO, 2015).Further,the agricultural sector provides employment opportunities for over 40 percent of the aggregate population and more than 70 percent of Kenya's rural population(GoK 2018).The smallholder tea sector is the second-largest agricultural exporter, providing a significant source of income that accounts for up to 4 percent of GDP(Kppra, 2017).

Currently, Kenya contributes about 10 percent of the global tea produce, making it the third-largest producer of tea after India and China (Kppra,2017). Tea farming in Kenya sustains more than 600,000 smallholder farmers who make about 60 percent of total tea produced.Smallholder farmers own approximately80 percent of the land bearingtea,withan average holding ranging from less than one hectare to 20 hectares(Kinyili, 2003).The Kenya Tea Development Agency(KTDA) provides management services to over 67 smallholder tea processing factories.(Mittei,2021). The management services include tea production, logistics, processing, transportation and marketing services. KTDA markets processed tea in foursignificantways, namely direct local sales accounting for3 percent ; factory door sales, 2 percent direct sale overseas, 14 percent; and Mombasa Auction, 79 percent (Wanjiru et al.2015).

There are many challenges that are facing the tea sector in Kenya which include low productivity rates, global oversupply of tea, political interference, multiple taxation regimes, low incentives to investment in value addition, high cost of production, differential green-leaf quality, low products diversification and governance issues with the institutions involved in the regulations (Wanjiru et al.,2015; Maina et al.2015).In addition, poor information flow on the modern production and management practices of tea poses a major challenge (Kariga et al. 2012).Furthermore,in Kenya, like in most developing countries, relevant, accurate and timely information dissemination and sharing among smallholder farmers plays a crucial role in permitting technology and knowledge transfer, mainly on income andproduction (Chimoita,2017).

Modern communication technologies can provide accurate, timely, relevant information and services to farmers to promote their informed decision-making (Usman,2021).Some of the modern communication technologies include; electronic green leaf weighing system, blue tooth enabled personal digital assistant gadgets, radio, social media, mobile phone technologies, and mobile phone money transfer services. However, despite the availability of information on modern technologies with the relevant sources of information, their retrieval and use for the betterment of the agricultural sector is low in developing countries because of broad gaps dominating between information sources and the information users (Samansiri, 2017).

In addition, mobile phone technologies are key in the access of market information on tea sales at Mombasa tea auction market. Mobile phone technologies convey real-time data on farmer's goods from centers to factories, enabling records management and payments possible. Despite the availability of these mobile phone money transfer services and databases, KTDA as management agent for smallholder farmers still transfer funds using the old bureaucratic methods (Mose, Mbeche&Ateka2016).Furthermore, the number of extension agents has been decreasing as farmers are increasing, leading to reduced production. Modern communication technologies thus can be used to address this backdrop (Kariuki, 2014).Modern communication technologies achieve information transfer more effectively than other communication methods among extension agents and farmers (Awan , 2019).

Communication technologies arecriticalin agricultural production, and they tend to enhance adequate access and use of agricultural information when utilisedappropriately. Relative advantage, compatibility and simplicity of ICTs influence farmers perception of the ICTs. Technologies that are more compatible with farmers existing values, past experiences and needs are accessed frequently and used more than those that are incompatible. Most farmers perceive ICTs to be easy to use, and when they are utilisedeffectively, they tend to enhance production due to timely and updated information, which is accessed and used.According toKante et al.(2017), farmers' perceptions of various technologies have proved to influence access, use, and uptake of the technologies, hence determining production. Therefore, there is a need to understand smallholder tea farmers' perceptions of access and use of modern communication technologies to enhance tea production to help formulate policies geared towards assisting farmers in realizing their expected production potential.

According to Mose et al. (2016), KTDA launched a modernisation process that comprised the computerisation of significantfield operations and factory production procedures to enhance efficiency. This undertaking included an electronic weighing system (EWS) in the green leaf buying chain. The system comprises a portable mini-computer,digital weigh scale and portable printer that allows real-time data transmission from the field to the factories. This innovation was embraced to facilitateinformation and data integrity, especially in the face of green leaf falsification thathad dominated several tea buying centres. EWS provides guaranteed backup and data security by ensuring that information is only provided to authorised users. Implementation of the system enhanced the accuracy of weights (up to 100 grams) using a lesser amount of labour, thus saving farmers on costs. It also significantly lowered grower complaints of records falsification at the tea buying centres. The study reveals that there is an emerging trend of tampering with electronic weighing scales. El Bilali andAllahyari(2018) defines ICT as technologies involved in collecting, storing, retrieving, processing, disseminating and implementing data and information using optics and telecommunications, microelectronics and computers. The study by Asenso-Okyere and Makonnen(2012), underscored the fact that ICTs include software, hardware, media for collection, processing, storage, transmission and presentation of information in any format, for example, text, data, voice and image, computers, CD-ROMs,the Internet, email, radio, telephone, video, television, digital cameras among others. El Bilali and Allahyari (2018) further noted that the vitality of ICTs in the development process was long recognized and the access to them was even made one of the criticalconcerns of the sustainable development goals number one, which put more emphasis on the benefits of new technologies, especially modern communication technologies in the alleviation poverty.The knowledge in ICTs and communication technology enables and promotes potential farmer's adoption and accurate services. A study by Oluoch and Osida (2015), states that a customer's comfort and trust level with a company or factory may increase, as they can acquire more information about a company through ICTs.

Communication technologies are key in agricultural production and they tend to enhance effective access and use of agricultural information when utilized appropriately. Relative advantage, compatibility and simplicity of ICTs influences farmer's perception of the ICTs. Technologies that are more compatible with farmers existing values, past experiences and needs are accessed frequently and used more compared to those that are incompatible. Most farmers perceive ICTs to be simpler and easy to use and when they are utilized effectively, they tend to enhance productivity due to timely and updated information, which is accessed and used.Acccording to Kante et al, (2017) farmer's perceptions on various technologies has proved to influence access, use and uptake of the technologies hence determining productivity. Therefore, there is a need to understand smallholder tea farmers' perceptions on access and use of modern communication technologies in enhancing tea production to help in formulating policies geared towards helping farmers realize their expected production potential.

Purpose and Objectives

The main purpose for this study was to evaluate smallholder farmers access and use of modern communication technologies in enhancing tea production.

Objective

1. To evaluate perceptions of access and use of modern communication technologies in enhancing smallholder tea production.
2.

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To determine the demographic characteisticsof respondents

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Materials and Methods

The study was conducted in ShinyaluSub-County of western Kenya in the year 2021(longitudes 34°48' 29''E and latitudes 0°13'26''N)with an establishment oftwo tea factories out of whichone factory has stalleddue to inadequate tea production.Shinyalu Sub-County is on the eastern side of Kakamega forest, and agriculture is the lifeblood for income to earn a living,with tea being the major cash crop. The study employed a cross-sectional study design, where data was obtained from smallholder tea farmers across Shinyalu Sub-County. The study was informedbythe diffusion of innovations theory(Rogers, 2003).An innovation is communicated via specificpaths among members of a society over time by focusing on knowledge and decision making that eventually leads to its adoption orrejection. The theory outlines five attributes of innovation, which influence the diffusion of innovation. Theseattributes include the relative advantage of technology, compatibility, trialability, complexity and observability. A mobile technology system pass real-time data on farmers' deliveries from centresto factories, enabling recordsmanagement and payments. As a result, approximately 75 per cent of tea farmers receive payments electronically or via checks from KTDA managed factories (Ktda,2014) For instance,currently, KTDA managed factories carry out factory door sales through Mpesa payments, which addresses the longevity concerns on the safety of cash at the factories and reduces the general inherent moneyhandling risks and increases accountability. This strategy translates into desirable and legitimate revenue management, leading to highreturns at the factories (Tiampati,2015).Data was collected from smallholder tea farmers.The farmers willingly gave their consent and permission to participate in the study.

The target population was 1,600 drawn from a list of farmers obtained from KTDA repository, from which 162 farmers were obtained using the formula recommended byFisher et al (1991).

$$n = \frac{P(1-P)Z^2}{d^2}$$

Where;
n=Population sample size

d=desired level of precision
p=Estimated proportion of the population of smallholder tea farmers in Shinyalu Sub County
z-the abscissa of the normal curve that cuts off an area at the tail (1.96 at 95% Confidence Interval)
The study assumed that 12% of the population in Shinyalu Sub County take part in tea farming.
At 95%, confidence interval-value is 1.96

$$n = \frac{0.12(1-0.12)1.96^2}{0.05^2}$$
=162 respondents

The study adopted the probability-sampling method whereby the respondents were selected using systematic sampling. The sampling frame comprised 1600 farmers. The sampling interval K was obtained using the formula k=$\frac{N}{n}$ (Mugenda and Mugenda, 2003) .Where; k=sampling interval, N=Population size, n=Sample size. k =$\frac{1600}{162}$ =10 .Therefore, data was collected from every 10thfarmer from the sample size of 1600 to get 162 farmers who were interviewe .A total of 159 farmers were successfully interviewed as three questionnaires were incomplete therefore excluded from the analysis. Semi-structured questionnaires and interviews were used to collect primary data. The Likert scale ranging from 1-strongly Agree and 5-Strong disagreement in terms of frequency of use, cost, accessibility, availability, accuracy, compatibility, ability, reliability and attributes of the technologies in tea management.

Data Analysis

Data wereanalysedusing quantitative and qualitative methods, deploying SPSS and excel packages and presented on tables and graphs. In addition, Chi-square was used to test the association between social-economic characteristics and the usage of Modern Communication Technologies (MCTs).

Results and Discussion

Demographic Data of the Sample

Results established the majority(69%) of the household heads were male; while the minority(29%) were female. This could be attributed to the fact that men are oftenly available for interviews and regarded as household heads in African set up and therefore managers of the land, various enterprises including cash crops such as coffee and tea (Peterman et al.,2011).However, the female households accounting for 29.3%could be attributed to the gender roles that confine women to intensive engagement in crop and livestock production at subsistence and commercial levels and provide much-needed labour services (Satyavathi et al.2010). The differences in gender in the household head could be due to the gender gap in agriculture in developing countries because women have limited access to resources such as land, credit facilities and opportunities such as decision making and management roles. The gender roles limit women in accessing modern technologies and decision-making opportunities to purchase inputs such as fertilizer, improved seeds and mechanical equipment andare much less likely to own land(Awan, 2019). However, agriculture creates many jobs for women in the agriculture sector, leading to greater earnings in the family (Baral et al, 2021).
In addition,mostof the respondents had acquired basic education, knowledge and skills (35.8%), suggesting that most farmers were literate and could use modern communication technologies in tea production. This finding concurs with a study by Kaweesa (2018), which asserted that a person's academic level is critical in enhancing uptake and interpretation and use of the information acquired.

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Furthermore, it was revealed that most(78.0%) respondentspractised tea farming as a cash crop and a primary monthly source of income. This implies that smallholder tea farmers primarily depend on tea farming as a source of income and livelihood. These results resonate with Anim-Dankwa (2018), that agriculture is the primary source of employment and income in developing countries. In addition, the majority(47%) of the respondents had spent 12 years in school (Table 1), indicating that farmers could make informed decisions regarding farm inputs new or improved technologies that could lead to uptake, hence increasing production and farm earnings. Further, the results concur with those by (Gikonyo,2022), who documented that educated farmers can follow instructions faster and adopt technologies more than illiterate farmers.

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Table 1: Demographic Data of the Sample

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Variable		Frequency	%
Gender of Household	Male	105	66
	Female	54	34
Family Position	H/H head (Male)	109	69
	H/H head (Female)	47	29
	Child >18yrs	3	2
Educational level	Lower primary	32	20
	Upper Primary	51	32
	Secondary School	57	36
	Tertiary	17	11
	University	2	1
Occupation	Formal employment	7	4
	Farmer	124	78
	Employed +Farmer	13	8
	Farmer Business	15	9
Years spent in School	8 years in school	14	9
	10 years in school	52	33
	12 years in school	75	47
	>12 years in school	18	11

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Farmers Perception on Tea Management Practices

Price determination, knowledge and marketing dynamics are very key determinants for increasing production practices and tea yields among farmers.The respondents were subjected to a Likert perception test and asked to express their opinion on agreement and disagreement on a five -point Likert scale.Results showed that most farmers were in total agreement that labour was available at 84.9% and affordable for land preparation, plucking and transportation of plucked tea to the buying centres.Further, the majority (55.9%) of farmers registered their opinion that tea income was unsustainable in accommodating tea production costs. This could be due to low producer prices and high production costs.These results are in discord with those of Gikonyo, (2022), which stated that higher tea productivity results in higher producer prices which can sustain smallholder farmers. Results further showed that the majority(68.6%)of the respondents, had limited knowledge regarding auction market outlets dynamics and price determination regimes. The results could be

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attributed to the weak communication network between KTDA as the management agents and the auction tea market players. In addition, clear market information flow increases the morale among smallholder farmers, making them opt for new markets or sell their tea in the free market (Chimoita, 2017). According to Maina et al. (2015), low tea prices constitute a significant challenge in tea production, leading to low morale among smallholder farmers, hence uprooting tea plantations.

Table 2: Farmers Perception on Tea Management Practices

Variable		Percentage (%)		
		Agree	Neutral	Disagree
Labor	Availability	85	4	11
	Affordability	49	21	29
Tea incomes (Sustainable)		21	23	56
Monthly income (Sustainable)		15	15	70
Second payment (Sustainable)		31	9	60
Tea markets (Knowledge on auction market prices)		25	6	69

Sources of Labor in Tea Production

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Labour is a fundamental factor promoting tea production at the smallholder level. Results indicated that the majority of the farmers, 63.40%, depended on hired labour for weeding, plucking and transportation of tea to the collection centres. Tea plucking and weeding are intensive practices requiring time and dedication that many households cannot sustain. The labour service provision deficiencies usually drive a majority of the households to seek hired labour services to complement family labour. However, in some cases, those households with larger family sizes at times engage family labour with a view of minimising costs of tea production.In addition, most of the households were approaching elderly age hence they could hardly work on this farms, therefore, the need for hired labour. The study by Thapa (2017) supports these findings by noting that hired labour complements family labour.

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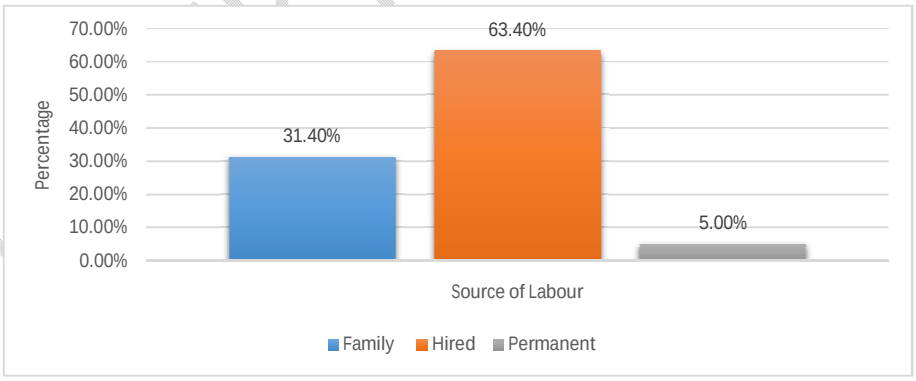

Figure 1: Sources of Labor Tea Production

Land Tenure Systems among Tea Farmers

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Land ownership is a very important factor in production of cash crops such as tea in Kenya. Results indicated that most of the farmers individually owned pieces of land and tea bushes(93%) (Figure2).Individual land ownership promotes the use and uptake of technologies such as modern communication technologies. Individual land ownership gives the farmer freeway to engage in any activity, tenancy rights, security,make critical decisions and access to credit (Chimoita,2017). Yego (2022) supports

these findings that land ownership is a vital prerequisite to farmers' investment, use and uptake of relevant technologies.Inaddition,a farmer that owns land is able to practice farming for a long time leading to experience in farming.Experienced farmers tend to adopt technologies faster than inexperienced farmers which leads to increase in production. These findings are in resonance with those of Ainembabazi and Mugisha (2014) that farming experience is an added advantage to improving production and uptake of farm innovations.

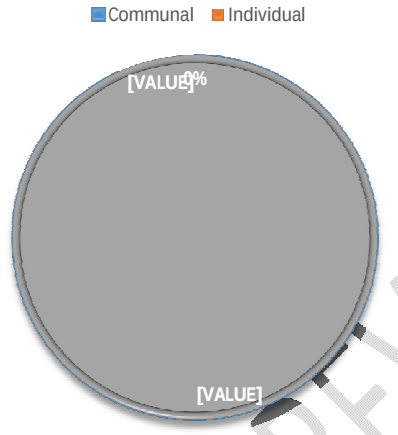

Figure 2: Land Tenure Systems among Tea Farmers

Farmers Perception on Use of MCT in Enhancing Tea Production

The study found that the majority of the farmers, with 70.2% perceived modern communication technologies to be more accessible,and 29.8% viewed the technologies as not being accessible. The majority, 59.7%,perceived that the technologies were more available, while 40.3% had a perception of the technologies as not being available. In addition, on ease of use of the technologies, 87.4% of the respondents believed that the technologies were easy to use, while 12.6% rated the ease of use to be more complex. On the accuracy of the technologies, the majority, 94.3%, perceived them as accurate while 5.7% believed that the technologies were not correct. Accessibility, availability and ease of use of technologies necessitate access and use among farmers.Similarly,Rogers (2003) indicated that less complex technologies are adopted and used faster than those that are more complex.

In addition, on compatibility, most of the respondents, 62.3%, viewed Modern Communication Technologies to be more compatible with existing infrastructure and 37.7% perceived the technologies incompatible. Further, on the cost of access of the technologies, the majority, 76.8%, perceived the technologies to be of high cost and 23.2% perceived the cost of access to be within their means. On the other hand, the majority of the farmers,83.0%,were able to use the technologies without any hindrance. This could be due to the available information on various platforms such as social media, which the smallholder farmers can use to share and use the same information to teach others. This is in resonance with a study by Ashank (2017) which stated that various technologies could be effectively used to share vast information among smallholder farmers.

Table 3: Farmers Perception on Use of MCT in Enhancing Tea Productivity

Variable		Frequency	Percent (%)
Accessibility to MCT	Accessible	112	70.2
	Not accessible	47	29.8
Availability of MCT	Available	89	59.7
	Not available	70	40.3
Ease of use of MCT	Easy to use	139	87.4
	Complex	28	12.6
Accuracy of MCT	Accurate	150	94.3
	Not accurate	9	5.7
Compatibility with existing infrastructure	Compatible	99	62.3
	Not Compatible	60	37.7
Cost of access of MCT	Accessible	37	23.2
	Not Accessible	122	76.8
Ability to use MCT	Able to use	132	83.0
	Not able to use	26	17.0

Farmers Perception on Reliability of MCT in Tea Production

The results indicated that mobile phone short messages were perceived by the majority, 76.1%, as reliable in delivering current information in tea production. In addition, on use of radio language revealed that the majority 74.3% agreed that the language used to deliver information on technologies was reliable and had a relative advantage in tea production.The majority of the respondents, 64.1% indicated that smartcard technology was reliable in the production of tea compared to hardcopies receipts that were prone to falsification.

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Further, Social media platforms, Facebook and WhatsApp, were perceived by the majority with 64.8% and 66.7%, respectively, as reliable in sourcing accurate and relevant data, which is critical in tea production. Social media technology has been perceived as reliable as it can be accessed easily by farmers. Through this platform, information on tea production and new technologies is found, leading to faster uptake of those technologies among potential farmers. Samansiri (2017) supports these findings by noting that social media, for example e-mail, is vastly used to disseminate information for the betterment of agriculture, leading to higher earnings among farmers hence improving livelihoods.

Table 4: Farmers Perception on Reliability of MCT in Tea Production

Variable	Percentage (%)		
	Reliable	Neutral	Not Reliable
Mobile Phone SMS	76	8	16
Radio Language	74	15	11
Smartcard technology	64	11	25
PDA technology	75	9	16

Facebook	65	7	29
WhatsApp	67	7	26

Farmers Perception on Attributes of Various MCT in Tea Management

The relative advantage of a technology attribute determines the likelihood of using or adopting a particular technology (Rogers,2003). The relative advantage of technology is how an innovation is perceived as better than the idea it supersedes. At the same time, compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters. The adoption of an incompatible innovation often requires the prior adoption of a new value system, which is a relatively slow process. The complexity of technology is defined as the degree to which an innovation is perceived as challenging to understand and use. In contrast, trialability of technology is the degree to which an innovation may be experimented with or on a limited basis. New ideas that can be tried on the instalment plan will generally be adopted more quickly than innovations that are not divisible.

Some innovations are readily comprehended by most members of a social system; others are more complicated and are adopted more slowly (Rogers 2003).Observability of a technology, is defined as the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt. Such visibility stimulates peer discussion of a new idea, as the friends and neighbours of an adopter often request innovation evaluation information about it. Farmers were asked to express their opinion on available MCT used in the tea sector versus relative advantage, compatibility, trial-ability and use.

Results indicated that mobile phone short messages had a 62% relative advantage (Table 5) over radio programmes. However, most of the respondents believed that time information is disseminated via radio had a more significant influence on the adoption rate. In addition, the results indicated that the language of relaying the message was very crucialamong the tea farmers.The study further established that the PDA scale had a 61% relative advantage over the hard copies handwritten scripts that indicated farmers'Greenleaf quantity. The PDA scale was instrumental in providing real-time data and record-keeping among farmers and trust. The PDA electronic weighing scale had a 55% relative advantage for delivering accurate data over the conventional weighing scales used at the factories, leading to farmers incurring losses. Smartcard technology had the highest relative advantage of 78% over hard copies weighment receipts. This is attributed to the fact that smartcard technology is an innovation and it has achieved high adoption rates among smallholder farmers. These findings corroborate with those of Ashank (2017), which asserts that technologies such as smartcard technology, radio and television provide real-time information to smallholder farmers.

Further social media technology had a higher relative advantage over extension agents and was compatible with existing farmers' infrastructure. For instance, email and social media platforms had a 52% relative advantage over conventional newsletters and pamphlets since farmers can get real-time information about tea production. In addition, YouTube technology had a 56% relative advantage over face-to-face meetings, contact farmers or extension service providers.This is because farmers could watch any production technology on YouTube from anywhere without travelling to tea training centres. Results from the study indicated that Facebook technology had a 52% relative advantage of meeting a large population of farmers compared to books to relay information on production (Table 5).As Rogers (2003) points out, technologies that meet the five parameters of adoption, the most important of which is a relative advantage over other technologies, are more likely to be used and adopted than technologies that do not have a relative advantage over other technologies.

Table 5Farmers Perception on Attributes of Various MCT in Tea Management

Variable		(%)				
		Relative Advantage	Compatibility	Trialability	Complexity	Observability
Mobile Phone SMS		62	21	8	2	7
Radio	Programmes	45	16	8	3	28
	Timing	51	10	6	7	26
	Language	49	3	8	8	32
Weighing Scales	PDA	61	13	10	6	30
	Electronic weighing	55	18	3	20	4
	Smart card	78	12	4	1	5
Social Media	Email	52	24	7	13	4
	WhatsApp	43	27	13	12	5
	YouTube	56	15	4	15	10
	Facebook	52	19	13	3	13

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Farmers Sources of Information on Tea Production

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The study examined where farmers sourced their information on production technologies. Findings showed that the majority of the farmers, 61% accessed extension services from agents on land preparation. The results could be because extension agents are more accessible and have the skills needed to disseminate particular technology.Further, the extension agents played a critical complementary role in unpacking and linking modern tea technologies from the source to farmers. These results concur with Phiri (2019), which states that most farmers obtain information from extension agents.Antony, (2022) similarly found that farmers ranked extension agents as a priority source of information. On the contrary, to these findings,Ekwang (2021) indicated that there were limited KTDA extension services, especially as the number of farmers increases. Further analysis showed that most farmers obtained information from fellow farmers,such as land preparation with 18.3% (Table 5).This could be due to the confidence and the horizontal type of communication the farmers have with their fellow farmers. These findings concur with those by Kigatiira.(2019), fellow farmers are personal dissemination channels of agricultural information in that skilled farmers become the best discussion partners for other farmers. Collectively, they evaluate the worthiness of technologies and suitability to their farming conditions (Van den Berg et al.,2020), leading to uptake of the suitable technologies.Analysis showed that the less number of farmers obtained information from books. For instance,1.9% of farmers obtained information on tea plucking from books, 0.6% of farmers on disease control from books, and 1.3% of farmers obtained information on pruning of tea from books and other sources.

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Table 6: Farmers Sources of Information on Tea Production

Variables	Percentage (%)						
	Extension Agents	Books	TRF	Tv	Radio	Mobile Phone	Farmer To Farmer
Land preparation	61	1.3	10.9	2.5	1.6	3.6	18.3
Nursery preparation	55.0	1.9	12.6	0.6	1.6	10.0	18.2
Transplanting	58.3	3.1	13.8	1.3	2.0	5.0	16.2
Planting	58.5	1.9	11.9	0.6	1.9	0.6	18.9
Spacing	58.5	3.1	13.2	0.6	1.3	4.4	18.9
Weeding	59.7	4.4	11.3	2.5	0.6	2.5	18.9
Plucking	62.3	1.9	11.9	1.3	0.6	2.5	19.5
Pruning	58.3	1.3	13.2	1.9	2.5	2.5	20.1
Fertilizer application	62.3	3.1	11.9	0.6	0.6	1.9	19.5
Disease control	61.6	0.6	11.9	1.3	1.3	3.8	19.5
Pest control	59.7	3.1	11.9	1.9	0.6	3.8	18.9

Association between Farmers' Characteristics and their Access, Use of Modern Communication Technologies

Comment [U30]: Please include this as an hypothesis

The study revealed an association (x^2 =12.71) between respondents' characteristics, for instance, education level and access and use of MCT, which significantly (p=0.01) influenced farmers' access and use of modern communication technologies. In addition, there was an association (x^2 =33.72) between distance to tea buying centre and access and use of MCT, which significantly (p=0.00) influenced access and modern communication technologies. These findings pointed out a strong association between farmers' characteristics and access and use of modern communication technologies.Raza (2020) affirm these findings by documenting that the education level of the respondents advances farmers' capacity to comprehend the benefits of innovations and technologies, leading to increased access and use of those technologies. Further, Chepkoech (2015) in her study of analysis of the use of participatory video shows that they tend to increase farmers easy access to information disseminated by the technologies, therefore reducing costs, providing timely and relevant information leading to increased productivity. Similarly, Ongachi (2017) found a positive influence onthe level of education and uptake of technologies.

Furthermore,the study revealed a positive association between gender of the farmersand access and use of MCTs,where male (x^2 =4.59); females (x^2 =12.85) and access and use of MCTs,which significantly (p=0.02;0.00) respectively influenced access and use of modern communication technologies in production of tea.WhereThis could be due to the fact that most of the females were involved in farming activity on the farms and could positively disseminate and share information on new technologies hence uptake and use of modern communication technogies unlike the males who despite them being many in the field ,most are old and hardly disseminate and share information on tea production and new technologies.Begho,2021 supports this findings by noting that gender differences have a positive influence on the uptake,access and use of technologies.Agriculture creates many jobs for women in the agriculture sector, leading to greater earnings in the family (Baral et al,2021)

Table 7: Association between Farmers' Characteristics and their Access, Use of Modern Communication Technologies

Farmer Characteristics	Chi-Square (x^2) Association Access and Use of MCT	P≤Value
Educational Level	12.71	0.01**
Occupation	9.14	0.03*
Distance to tea buying center	33.72	0.00**
Male	4.59	0.02*
Female	12.85	0.00**

N=159 Statistical Significance levels **p<0.01;*p<0.05 where means ** high significant

Conclusions

It is concluded that most the tea farmers had acquired basic literacy levels of education to use modern technologies in tea production.Farmers' educational level influenced the access and use of modern communication technologies. Smallholder tea production was practiced on individual owned farms and farmers primarily practiced tea growing as acash crop for income and livelihood.Labour was available but costly in terms of sustaining land preparation,pickingand pruning of tea.Majority of the household were male headed while the minority were female headed.Tea incomes were unsustainable and could not consumerate tea production costs.Itwasalsoconcluded thatmodern technologies such as smartcard technology, mobile phone text messages and personal digital assistants had a relative advantageof enhancing access and use of farm inputs, market information and tea management information as opposed to conventional and existing technologies. A positive association was revealed between farmers' educational level and the use of modern communication technologies, which influenced access to MCT.A positive association was also revealed between distance to tea buying centres and use of MCT,which influenced access and use of the MCTs.The extension agents played a critical complementary role inunpacking and linking modern tea technologies from the source to farmers.

Comment [U31]: Of

Recommendations

Based on the study findings, the study recommends thatsmallholder tea farmers should be imparted with skills on how to utilise the highly accessed MCTs, for example, smartcard technology, mobile phone short text messages to enhance access to information which will lead to increased production.Secondly, the county governments, Kakamega and Vihiga, should embrace the use of MCTs to reach the many smallholder farmers and train them to improve production for income generation Smallholder farmers primarily seek information on tea production from extension agents. Therefore, the extension agents at the tea factories should use MCTs to disseminate information to promote faster dissemination and adoption of technologies among farmers.Lastly,Mudete tea factory should integrate and utilize the available MCTs to pass relevant, timely and accurate information to smallholder tea farmers, such as WhatsApp groups and mobile phone text messages to reach many farmers within the shortest time possible.Future study should focus on effect of gender differences on access and use of modern technologies influencing tea productivity.

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