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Influence of access to extension services on milk productivity among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya

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ABSTRACT

Inaccessibility to extension services by smallholder farmers remains one of the impediments to achieving high agricultural productivity and food security. Extension services play a critical role in information dissemination that can avert food insecurity and increase smallholder dairy farmers' incomes. However, access to extension services remains a significant challenge in developing countries. This study investigated the influence of access to extension services on milk productivity among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya. The study's target and accessible population was 17,000 smallholder dairy farmers. The study used simple random and proportionate sampling techniques to select study farmers. Nassiuma's formula generated a sample of 120 smallholder dairy farmers. The hypothesis underwent testing using simple linear regression. The regression results found a statistically significant influence between access to extension services and milk productivity at a 5% significance level ($p < 0.05$). Findings show that most smallholder dairy farmers accessed extension services through television, radio, neighbours, and friends. In contrast, the top animal husbandry practices that most farmers were interested in were parasite and disease control, breed selection, and feed preparation. The Government of Kenya mainly provided vaccination services, while the other veterinary services, including deworming, pregnancy and disease diagnosis, breed selection, and treatment, were dominated by private entities. The Government of Kenya should improve smallholder dairy farmers' access to extension services. The study recommends channeling agricultural information in all possible vernacular languages and Kiswahili, the national language, via television and radio platforms to reach all smallholder dairy cow farmers. Additionally, more emphasis should be on the importance of appropriate milking techniques and record-keeping among smallholder dairy farmers to help monitor their animals' health, feeding, breeding, and milk productivity.

1. Introduction

Agriculture contributes to economic development [1–3]. A critical sub-sector in agriculture is dairy. The sub-sector employs approximately 1.3 billion people worldwide, with smallholder dairy farmers accounting for more than 150 million farms, especially for livelihoods [4]. Worldwide milk production was 883,283.7 thousand tonnes in 2019 [5]. The leading annual milk producers in the

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world were: India, with a production of 187, 633.0 thousand tonnes, followed by the United States of America (USA), which produced 99,082.0 thousand tonnes, Pakistan was third with 55,957.2 thousand tonnes, while China and Brazil were ranked fourth and fifth with productions of 36,792.8 thousand tonnes and 36,174.1 thousand tonnes respectively [5]. The annual production level for Africa was 48,073.7 thousand tonnes [5]. The leading African milk producers were Kenya (5528.9 thousand tonnes), Egypt (4645.8 thousand tonnes), Sudan (4623.0 thousand tonnes), Ethiopia (3644.0 thousand tonnes) and South Africa (2287.3 thousand tonnes) [5].

There are approximately 59 million dairy cows in Africa, which account for 80% of the continent's milk yield [6]. Eastern Africa produces half of that amount of milk, followed by Central, Southern, and Western Africa [6]. However, Eastern Africa's milk productivity is low since the average annual milk productivity ranges between 850 and 3150 kg/cow/year [7]. The average milk productivity in Eastern Africa in pure dairy cow breeds is around 2000 kg/cow/year, 1000 kg/cow/year in crossbred dairy cows, and 500 kg/cow/year in indigenous cows [7]. There is a need to implement mechanisms to address the milk productivity challenges in Africa and Eastern Africa. Addressing the productivity challenges will help boost food security for the anticipated population growth.

In 2015, the United Nations (UN) projected an increase in the world's population from 8.3 to 10 billion people by 2050 [8]. This population growth will increase the demand for cow's milk by over 2% annually [9]. A considerable percentage of this demand will emanate from third-world countries. For instance, in Eastern Africa, the cow's milk market is forecasted to rise by 43% by 2050 [10, 11]. According to Mwanga et al. [9], this demand calls for increased milk productivity to sustain the projected global population growth. Dairy farming can help cater to the nutritional needs of the ever-growing human population [12]. Organizations and countries are strategizing visions and objectives that can alleviate the world's food insecurity challenges.

The UN's second Sustainable Development Goal (SDG) is consistent with Kenya's Vision 2030, which aims to combat hunger and poverty by increasing smallholder dairy farmers' milk productivity by 6%–8% annually [13]. According to Staal et al. [14], more emphasis should be on formulating and implementing farmer-friendly dairy policies for improved milk productivity. The Kenyan government can improve milk productivity by having a robust institutional support framework that provides relevant support services to Kenyan smallholder dairy farmers [15]. Against this backdrop, the Kenyan government in 2013 developed the National Dairy Development Policy Framework (NDDPF) to improve dairy farmers' productivity and contribute towards food security [16]. Implementing this policy is expected to improve smallholder dairy farmers' productivity by creating an enabling environment for access to milk productivity resources.

The NDDPF outlines policies guiding dairy cow breeding, access to extension services, animal health, veterinary services, and feed quality assurance [17]. However, the Government of Kenya (GoK) has not fully implemented the policies that support smallholder dairy farmers' access to extension, veterinary, and breeding services [17]. The gaps in service delivery are due to inadequate financing for extension service delivery, poor coordination between agricultural stakeholders, and uncoordinated activities within the Kenya Dairy Board (KDB) [17]. Therefore, the Kenya dairy sector stakeholders should address these challenges to improve institutional support provided to smallholder dairy farmers.

Poor policy implementation in extension service delivery has negatively affected Kenyan smallholder dairy farmers, who produce 80% of the country's cow milk and contribute 14% and 3.5% of the agricultural and national Gross Domestic Products (GDPs) [18]. Cow milk is central to most Kenyans' breakfast budgets and household diets and is Kenya's second most crucial livestock product after meat [19]. This demand is evident in Kenya's high per capita milk consumption of approximately 80–100 kg per year, four to five times that of other Eastern African countries [20]. Despite the high demand for milk, its productivity in Kenya is approximately 5.46 L/cow/day against the potential of producing above 12.0 L/cow/day [21]. Several challenges contribute to low milk productivity in Kenya.

Some constraints to achieving high milk productivity in Kenya include climate change [21]. Due to the threat to agriculture, on which smallholder farmers mainly rely for their livelihood, climate change makes it harder for farmers to meet their productivity requirements now and in the future [22]. Climate change compromises water and dairy cows' feed availability. Animal diseases, inbreeding, calf mortality, high abortion rates, lack of milk storage facilities, and human encroachment into grazing lands compromise milk productivity [21]. Reduced genetic potential for indigenous cattle breeds and limited extension services also hamper productivity [23]. Also, little knowledge of animal breeding practices such as Artificial insemination (AI) inhibits food security [2]. The Kenyan dairy industry can fully exploit its milk productivity potential by navigating the existing institutional constraints that play a significant role in farmers' accessibility to dairy production resources and agricultural extension information [21].

Institutional factors refer to complete joint aspects involving procedures, legal contracts, constitutions, and pacts regulating people's right to use services and resources [1]. These resources and services include feeds, water, breeds, and veterinary and extension services [21]. Therefore, milk productivity in Kenya can be improved through enhanced accessibility to extension services [9]. Access to quality extension services positively impacts milk productivity [24]. Extension services disseminate advisory services that build farmers' resilience towards production challenges such as diseases and climate change [25]. Extension services also provide farmers with non-formal agricultural education through short training in animal husbandry that improves their dairy animals' performance [5]. Such activity also builds farmers' resilience towards challenges such as climate change, diseases, feed availability, and animal genetics which are essential in milk productivity.

The operationalized definition of extension services in the context of this study encompassed (i) frequency of access to extension services by smallholder dairy farmers from various sources, (ii) frequency of access to information on animal husbandry practices, (iii) frequency of applying the animal husbandry practices and, (iv) access to veterinary services. Extension service delivery's influence in the agricultural sector remains an international challenge. It is vital to comprehend the capacity ability of extension services to promote sustainable agriculture [26]. Among the principal sources of income for households in Nakuru County, Kenya, is dairy farming [27]. However, Njoro Sub-County's milk production is still below its potential of producing up to 39 million litres annually against the 18.5 million litres produced by dairy farmers in 2017 [28]. The decline continued to 16.57 million litres in 2018 and 16.25

million litres in 2019 [29]. However, researchers have conducted very few investigations to determine why this trend exists. Therefore, this study aimed to determine the influence of access to extension services on milk productivity among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya.

1.1. The significance of the study

The study findings will inform policymakers in Kenya's Ministry of Agriculture, Livestock, and Fisheries (MoALF) on the influence of access to extension services on milk productivity. The findings may enlighten their decisions to take appropriate measures to improve access to extension services and milk productivity. Further research on untackled factors influencing milk productivity among smallholder farmers in Njoro Sub-County, Nakuru County, Kenya, may be premised on this study's findings.

1.2. The study's conceptual framework

The study's conceptual framework [Fig. 1] summarizes the relationship between the study's independent and dependent variables. The study's independent variable was access to extension services which referred to the frequency of access to extension services from the Government, agro-dealers, Non-Governmental Organizations (NGOs), Savings and Credit Cooperatives (SACCOs), universities, Television, radio, research institutions, mobile phones, neighbours, and friends. Access to extension services also referred to the frequency of access to information on animal husbandry practices that included breed selection, feed preparation, feeding, watering, parasite and disease control, cowshed maintenance, breeding, milking, and record keeping. Access to extension services also studied the frequency of applying animal husbandry practices and the frequency of access to veterinary services, including dairy cows' vaccination, disease diagnosis, treatment, pregnancy diagnosis, deworming, and treatment.

Milk productivity was the dependent variable. The research measured milk productivity in terms of milk produced per day in litres per dairy cow. Membership in farmer groups was the intervening variable. An intervening variable represents external aspects the researcher has no control over, yet they affect the relationship between a study's independent and dependent variables [30]. The study controlled membership in farmer groups through simple random sampling, which ensured the inclusion of farmers in groups and those who were not.

1.3. Theoretical framework

Ajzen's Theory of Planned Behaviour (TPB), 1991 informed this study [Fig. 2]. The Theory of Planned Behaviour states that intentions are the best predictors of human behaviour. The theory further stipulates that before an individual takes any action, they must have thought about it. The theory looks at three main predictors of human intentions: behavioural attitude, subjective norms, and perceived behavioural control [31]. Behavioral attitude is about how one thinks, feels, and has expectations about a specific behavior. It further subdivides into affective attitude and subjective attitude. Affective attitude involves one's belief in behavior to be enjoyable or not. On the other hand, instrumental attitude is someone's perception of behavior as beneficial or harmful to them [31].

The second predictor is subjective norms. These norms involve the support the family, friends, and others give to adopt a certain behavior or practice. Under subjective norms, there are injunctive norms and descriptive norms. Injunctive norms describe the

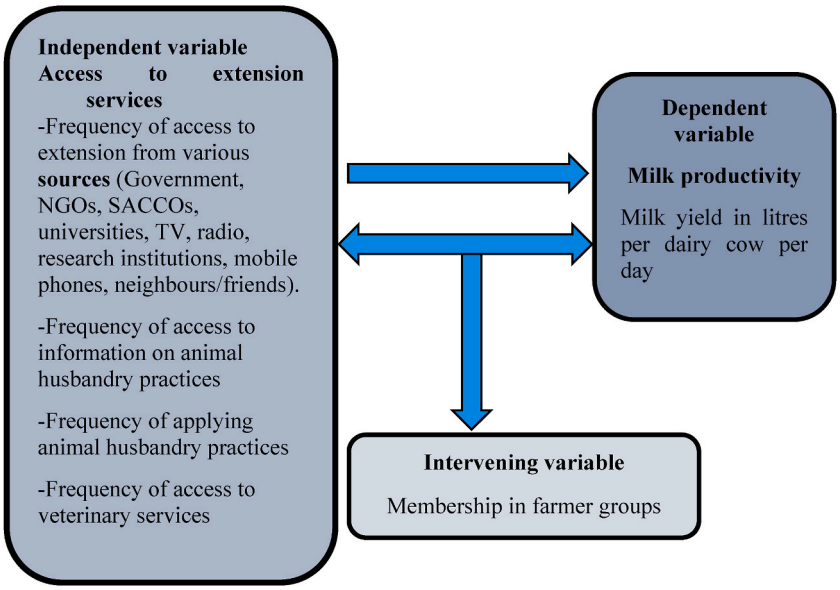


Fig. 1. The study's conceptual framework.

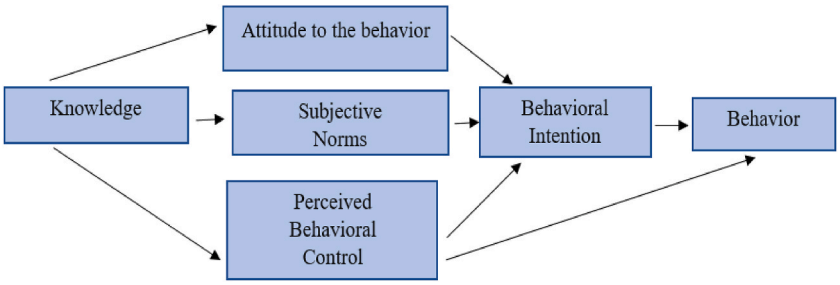


Fig. 2. The theory of planned behaviour.

encouragement by one's social network to engage in certain behavior. In contrast, descriptive norms refer to one's uptake of behavior because others in their social networks engage or do not engage in the behavior [31].

In the context of this study, a dairy farmer will invest and strive to increase milk productivity if they know its benefits and anticipated challenges. It will also depend on whether they consider it beneficial and profitable to them and vice versa. Other factors

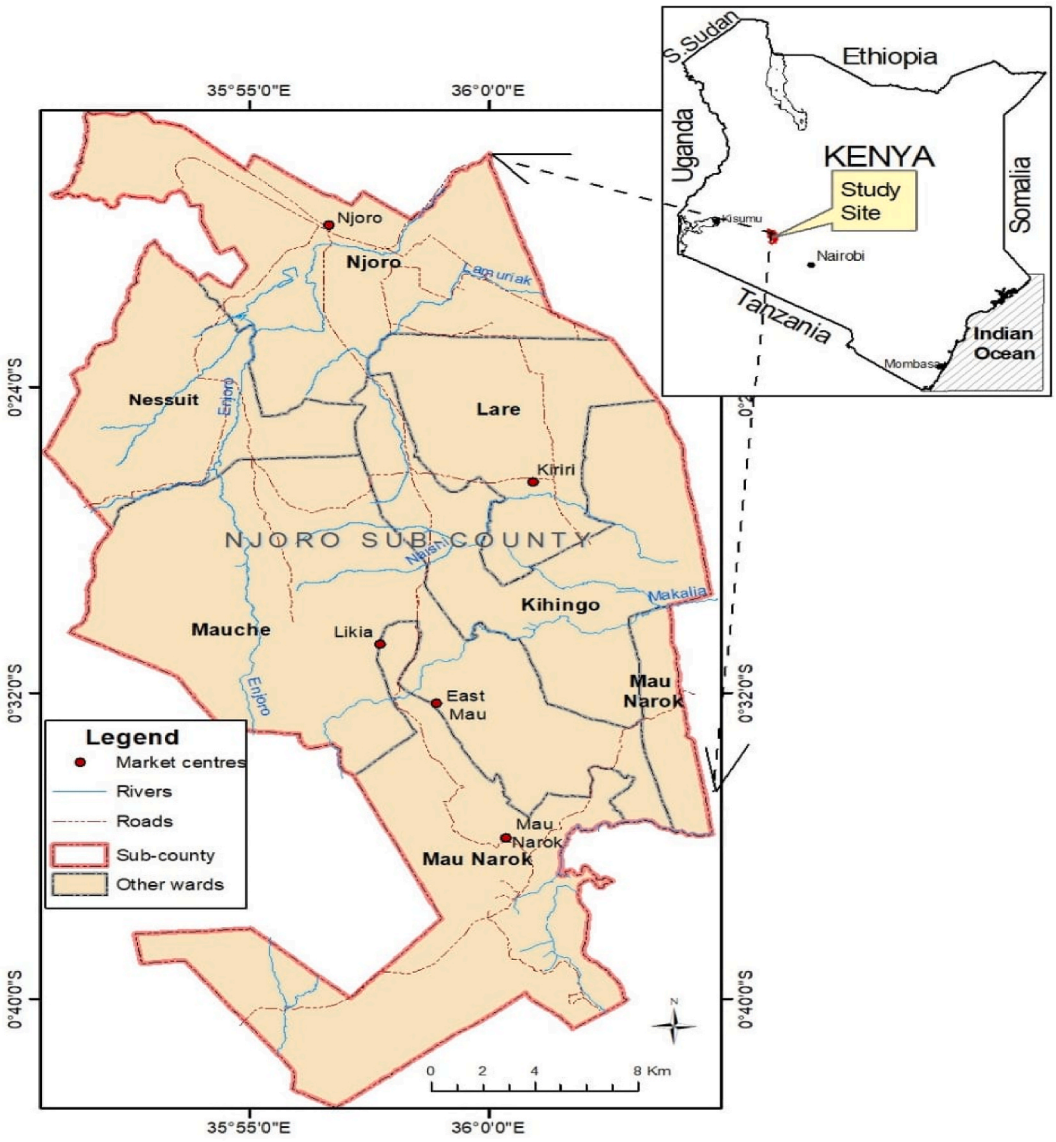


Fig. 3. Map of the study area.

likely to determine their participation and success in the dairy enterprise include support from relevant stakeholders in the dairy production value chain. For instance, government policies aligned with their dairy production needs can contribute to sustainable productivity. Dairy farmers also conduct a cost-benefit analysis before considering adopting certain breeds or production methods concerning their access to credit and any other support. A farmer performs a cost-benefit analysis concerning the ease of access to inputs such as credit, feeds, and breeds.

In perceived behavioural control, the farmers will appreciate milk productivity if they can overcome any barriers such as animal diseases, the resilience of the animals to weather changes, skills and knowledge in milk production and availability of capital, and the ease with which they can carry out their day-to-day activities. Smallholder dairy farmers can overcome these barriers through easy access to extension services, credit, and other farm inputs that increase milk production, such as animal feeds. This theory, therefore, informs this study because farmers will require knowledge of factors facilitating milk productivity. Adopting or rejecting enhanced milk productivity practices will influence their adoption or rejection of certain practices. They will also form a favorable attitude towards milk production depending on how they are supported to access extension services, especially by the government.

1.4. The limitation of the study

The limitation of the study was the language barrier since the questionnaire was in English. To address this limitation, the extension officers from the six study wards and one research assistant underwent training before data collection. To improve its reliability, they helped translate the instrument into Kiswahili and the local languages, mainly Kikuyu and Kalenjin, to the smallholder dairy cow farmers in Njoro Sub-County, Nakuru County, Kenya.

2. Materials and methods

2.1. Description of the study area

The study was conducted in Njoro Sub-County of Nakuru County in Kenya (Fig. 3). Njoro Sub-County comprises Mauche, Lare, Kihingo, Nessuit, Mau Narok, and Njoro wards and covers an area of 713.3 square kilometres with a total population of approximately 238,773 people [32]. Njoro ward is Njoro Sub-County's headquarters, located 18 km southwest of Nakuru Town. Njoro lies between Longitude 35° 45′ 0 and 36° 10′ 0 East and Latitude 0° 15′ 0 and 0° 42′ 30 South at approximately 1,800 m above sea level. The main economic activities include barley, wheat, potato farming, dairy, and horticulture. The Mau Forest, which covers 885 square kilometres, is one of its significant environmental assets contributing to the region's annual rainfall of approximately 1700 mm [32]. Njoro Sub-County was purposively selected for the study because dairy farming is one of the Sub-County's main economic activities [28]. The smallholder dairy farmers in the Sub-County own between 2 and 5 heads of cattle under farm sizes of about 1–2 acres [28].

Generally, milk production and productivity in Kenya fluctuated between 2017 and 2021, as seen in Table 1. The Table provides the overall dairy production data regarding the number of cattle, production in tonnes, and yield in 100g/animal annually in Kenya, which mirrors the average trends in most milk-producing areas, like in Njoro Sub-County in Nakuru County, Kenya.

From the results generated by the Food and Agriculture Organization Statistics (FAOSTAT) for Kenya's dairy production and productivity, between 2017 and 2021, 2020 was the year Kenya had the highest number of cattle, while 2017 and 2018 had the lowest for that span of five years. However, despite 2020 recording the highest number of cattle, the production in tonnes was highest in 2021 despite a reduction in the cattle population in Kenya between 2020 and 2021. The increased production in 2021 was due to the high milk productivity per animal, whereas in 2021, Kenya generally experienced high annual milk productivity of 924,800g/animal. The data shows that milk productivity per animal is critical in boosting general milk production in a country.

2.2. Target population

The target population comprised 17,000 smallholder dairy cow farmers in Njoro Sub-County, which has six wards. In this study, smallholder farmers refer to those farmers who own three dairy cows and below. The study's accessible population is the same as the target population. The distribution of the 17,000 farmers across the six wards under study is as follows Mau Narok 3258; Mauche 3131; Kihingo 2447; Nessuit 1240; Lare 1643; Njoro 5281 [29].

Table 1
A summary of dairy production in Kenya between 2017 and 2021.

Years Parameters	2017	2018	2019	2020	2021
Number of cattle	18,338,810	19,635,142	20,882,488	26,765,935	22,853,225
Production in tonnes	3, 560,702	3, 778,207	3,983,250	4,048,117	4, 640,860
Yield in 100g/animal	6474	7360	8627	7918	9248

Source [33].

2.3. Sampling procedure and sample size

The researchers used Nassiuma's coefficient of variation formula to calculate the sample size, as shown in the equation below.

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

From the formula, ***n*** was the required sample size, **N** was the target population, ***C*** was the coefficient of variation, and ***e*** was the standard error value. The acceptable standard value for the coefficient of variation was 0.21, while the standard error was 0.02 [34].

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

$$n = \frac{17,000x\ (21\%)^2}{(21\%)^2 + (17,000-1)0.02^2}$$

$$n = 109$$

The study used the above formula to sample 109 smallholder dairy farmers. The sample size was above 100, the minimum recommended number for samples in survey studies, and was therefore considered appropriate for accuracy [35]. Additionally, the researcher included an extra 10% of 109 (11 respondents) in the sample bringing the total number of respondents to 120 (Table 2) provides the breakdown. The addition helped to cater to attrition and non-responses [36].

Table 2 provides a summary of smallholder dairy farmer's distribution across various wards in Njoro Sub-County, highlighting their estimated numbers, proportions in relation to the total, and the sample sizes employed for data collection. There are 17,000 smallholder dairy farmers across all wards, with a total sample size of 120 for the entire study.

2.4. Data collection

The study was conducted from February 2022 to April 2022 with the help of the ward agricultural extension officers who mobilized the smallholder dairy farmers in the six study wards. Data was collected using semi-structured questionnaires whose content aligned with the research objectives and hypotheses. The questionnaire makes coding and analysis of the data easy [37]. Questionnaires also ensure consistency and uniformity of instrument items across the study's respondents [37]. The effectiveness of a data collection instrument determines its validity in covering the area of investigation by measuring what it was intended to measure [38]. A questionnaire's face validity is determined through its appearance, readability, unambiguity, consistency in formatting, and language clarity [38]. To gauge a questionnaire's validity, scrutiny by a panel of experts in the area under study helps identify errors and provide feedback for improving it [39]. Professionals from the Faculty of Education and Community Studies, Department of Agricultural Education and Extension, and the Faculty of Environmental Resources Development, Department of Natural Resources at Egerton University determined the questionnaire's validity. The experts went through the research objectives and instruments. The expert recommendations helped improve the instrument's validity.

Reliability is the extent to which a data collection instrument provides consistent results in varying environments and conditions [38]. The researcher established the questionnaire's reliability through a pilot study on 30 randomly selected smallholder dairy farmers in Elburgon Ward in Molo Sub-County. The selected farmers had similar socio-economic characteristics to those in the research study wards [40]. Kathuri and Pals [35] recommended that for surveys, a sample size for pilot testing should be between 25 and 50. The Cronbach Alpha Scale helped determine the questionnaire's reliability. The questionnaire generated a reliability coefficient of 0.864 (Fig. 4) which met the recommended reliability threshold of 0.70 and above [41] and was deemed fit for the study.

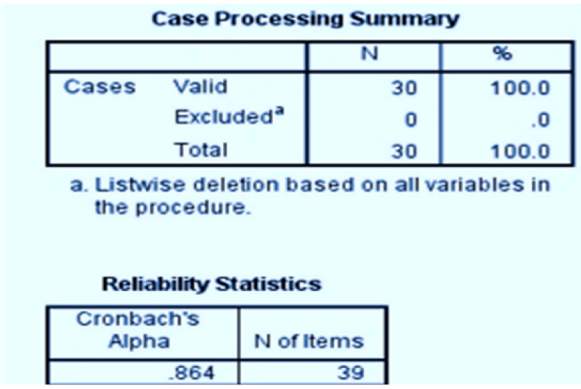
2.5. Ethical approval for data collection

The National Commission for Science, Technology, and Innovation (NACOSTI) permitted data collection under research Permit Number NACOSTI/P/21/14424. The research permit was then presented to the County Agriculture office to allow for data collection

Table 2
The proportion of smallholder dairy farmers' samples sizes across wards.

Ward	Estimated no. of smallholder dairy farmers	Proportion	Sample size
Mau Narok	3258	19.16	23
Mauche	3131	18.42	22
Kihingo	2447	14.40	17
Nessuit	1240	7.29	9
Lare	1643	9.66	12
Njoro	5281	31.10	37
Total	**17,000**	**100**	**120**

Source: [29].



Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.864	39

Fig. 4. Questionnaire's pilot study reliability results.

from the study wards. Appointments with the smallholder dairy farmers were coordinated through the Njoro Sub-County livestock officer and ward agricultural extension officers. The collected data was cleaned and keyed into the IBM Statistical Package for Social Sciences (SPSS) version 22. Descriptive statistics (frequencies and percentages) analyses showed the frequency of access to extension services, frequency of access to animal husbandry information and frequency of applying animal husbandry practices, and frequency of access to veterinary services by smallholder dairy farmers.

2.6. Data analysis

Descriptive statistics helped to generate data on the frequency of access to extension services, frequency of access to information on animal husbandry practices, frequency of applying animal husbandry practices, and access to veterinary services. Simple linear regression was used to determine the influence of access to extension services on milk productivity. Analysis of the influence of access to extension services on milk productivity involved generating composite data by computing a new variable by summing up all responses under each measure for access to extension services as selected by the respondent and dividing it by the total number of items under that section. The composite data results for each respondent were then analyzed against milk productivity.

Simple linear regression analysis determined the influence of access to extension services

on milk productivity with the equation, $Y = \beta_0 + \beta_1 x_1 + \varepsilon$; Where Y = milk productivity, β_0 = intercept (Regression constant), β_1, coefficient of determination, x_1 = Access to extension services, ε = random error term. Statistical significance between frequency of access to extension services, frequency of access to animal husbandry practices, frequency of application of animal husbandry practices, and frequency of access to veterinary services on milk productivity was reported if the p-value was <0.05.

3. Result and discussions

3.1. Frequency of access to extension services

The **first indicator** for determining the influence of access to extension services on milk productivity was the frequency of access to

Table 3
Frequency of access to extension services.

	Smallholder dairy farmers (n = 120), F=Frequency									
	Frequency of contact with extension service providers									
Extension Services sources	Never		Rarely		Occasionally		Often		Very Often	
	F	%	F	%	F	%	F	%	F	%
Government	59	49.2	42	35.0	13	10.8	3	2.5	3	2.5
Agrodealers	13	10.8	30	25.0	57	47.5	9	7.5	11	9.2
NGOs	91	75.8	24	20.0	4	3.3	1	0.8	0	0.0
SACCOs	107	89.2	5	4.2	7	5.8	1	0.8	0	0.0
Farmer groups	60	50.0	26	21.7	19	15.8	8	6.7	7	5.8
Research institutions	84	70.0	25	20.8	9	7.5	2	1.7	0	0.0
Universities	90	75.0	21	17.5	7	5.8	2	1.7	0	0.0
Television	18	15.0	4	3.3	17	14.2	9	7.5	72	60.0
Radio	22	18.3	13	10.8	21	17.5	10	8.3	54	45.0
Mobile phone	74	61.7	15	12.5	6	5.0	7	5.8	18	15.0
Neighbours and friends	24	20.0	16	13.3	28	23.3	26	21.7	26	21.7

extension services from specific extension sources. The smallholder dairy farmers were asked to indicate the frequency of access to extension services from the Government, NGOs, agro-dealers, SACCOs, farmer groups, research institutions, universities, television, radio, mobile phone, neighbours, and friends. Descriptive statistics helped determine the frequencies and percentages of the smallholder dairy farmers who accessed extension services from various sources. The descriptive statistics results on the frequency of access to extension services by smallholder dairy farmers from multiple extension service providers are in Table 3.

Frequency of access to extension services by smallholder dairy farmers ranged from never (0 times), rarely (1–2 times), occasionally (3–4 times), often (5–6 times), to very often (more than six times) quarterly. The leading institutions from which most smallholder dairy farmers never accessed extension services included SACCOs (89.2%), NGOs (75.8), universities (75%), research institutions (70%), and mobile phones. In comparison, the sources from which smallholder dairy farmers very often accessed extension services were television (60%), radio (45%), and neighbours/friends 21.7% (Table 3). The research findings contradict Jumba et al. [42] assertions that most Kenyan smallholder farmers usually access extension services mainly from the government. The inaccessibility is because government extension service delivery is often hindered by underfunding and understaffing, limiting the number of farmers an extension officer can reach [43]. The number of agricultural extension officers limits accessibility to extension services.

Smallholder dairy farmers experience challenges accessing extension services from government officers due to the low ratio of extension officers to farmers (1:1000), which does not comply with the Food and Agriculture Organization's (FAO) recommendation of 1:400 extension officers to farmers balance [43]. Following the challenges mentioned above, other players, including NGOs, universities, cooperatives, agro-dealers, research institutions, private entities, and media platforms, have emerged to cater to the growing demand for quality extension services [44]. Owning a radio or television increases the chances of acquiring extension information [45]. In this study, smallholder dairy farmers very often accessed their extension messages via television and radio (Table 3).

Radio has been effective in agricultural information dissemination, especially in remote areas. Radio does not always require electricity; it is mobile and has most of its programs in vernacular language compared with television [46,47]. Farmers also prefer radio due to the participatory nature of programs that allow for interactions among farmers and various stakeholders in the extension delivery system, such as agricultural officers [45]. However, in this study, smallholder dairy farmers agreed that extension services were more accessible through television and radio. The timing of agricultural programs on '*Mugambo wa Murimi* on *Inooro'* Tv, a television program in Kikuyu language, and *Chamgei* in Kalenjin languages which air agriculture-related programs at 8.30 p.m. were convenient for the farmers.

The research findings in Table 3 also showed that 21.7% of the smallholder dairy farmers accessed extension services through their neighbours/friends. These findings correspond with what Waaswa [48] found out in Gilgil, Nakuru County, that farmer meetings allowed farmers to share their farming experiences and learn how to overcome particular challenges in food production. Additionally, reliance on neighbours and friends for agricultural information is due to convenience and trust among farmers [42]. Farmer groups are significant in agricultural information dissemination since, in this study, 5.8% of farmers very often received information via farmer groups (Table 3). Groups also ease farmer training by improving their mobilization compared to dealing with individual farmers [42]. Farmers did not very often use SACCOs to access extension services (Table 3), probably because most smallholder dairy farmers are usually reluctant to join SACCOs due to the compulsory subscription fees and the perceived biases towards progressive farmers [49]. Additionally, most farmers may not benefit from joining SACCOs out of social pressure rather than reaping their economic benefits [49,50].

Agro dealers provide farmers with pesticides, tools, seeds, and fertilizers. Since most agro-dealers have a background in agriculture, they also offer extension services by disseminating information about the latest innovative advancements in breeds, feeds, and mechanization [51]. According to La Montagne et al. [52], farmers seek extension services from agro-dealers due to the quality of the information provided and the trust established, especially from purchasing farm inputs from specific agro-dealers over a prolonged period.

Smallholder dairy farmers did not very often use NGOs to access extension services (Table 3). The main challenge was the longevity of NGOs in most areas [53]. NGOs are usually short-term and cannot be entirely relied on by farmers. These findings concur with Mwololo et al. [53] that although NGO extension services are affordable and might cover substantial geographical areas, they are usually short-term and sometimes give conflicting messages that confuse farmers on what to adopt. Most farmers, therefore, do not rely on NGOs due to their instability and unsustainability since most NGOs withdraw from communities once the donors' funding ends, leaving behind incomplete projects.

Most public universities address social issues through community outreaches and extension [54]. However, in this study, universities were also not very often used to access information on dairy production (Table 3). Possible reasons could be transportation issues on the part of the farmers, whereby it might be expensive to travel to universities for consultation [55]. On the part of universities, staff may be unable to organize outreach programs due to bureaucracy issues and underfunding. The findings correspond with Swanberg et al. [55] that underfunding, understaffing, difficulty retaining farmers during training, and difficulty scheduling training favorable to farmers' schedules affect extension service delivery to farmers.

As indicated in Table 3, 15% of the respondents used mobile phones very often. This trend may be due to network and other phone-related challenges, such as the operation of agricultural applications. According to Emeana et al. [56], most African farmers may not access mobile phone extension services since they do not own smartphones and cannot browse. Those with smartphones are inadequately trained to utilize various agriculture-related applications [56]. Additionally, lack of electrical connectivity, the high cost of subscription to the agricultural applications, and a 'one size fit all' approach towards modelling the agricultural mobile application are a challenge to accessing extension services via mobile phones [56]. However, Okello et al. [57] argued that most farmers accessed agricultural extension information via mobile phones, compared to radio and television platforms. With mobile phones, one can access information at any time, unlike radio and television, where one needs to tune in at that moment or be available to watch the program

during its broadcast.

3.2. Frequency of access to information on animal husbandry practices

The **second indicator** for determining the influence of access to extension services on milk productivity was the frequency of receipt of extension services for designated animal husbandry practices. In the study, access to extension services was determined by indicators of frequency of access to extension services and frequency of access to information about specific animal husbandry practices. Concerning the frequency of access to information on specific animal husbandry practices, smallholder dairy farmers in Njoro Sub-County were asked to indicate the frequency of receipt of information on various animal husbandry practices. The frequency ranged from never (0 times), rarely (1–2 times), occasionally (3–4 times), often (5–6 times) to very often (more than 6 times) quarterly. Frequencies and percentages were generated regarding the extent to which smallholder dairy farmers in Njoro Sub-County received agricultural information on the listed animal husbandry practices as shown in Table 4.

Frequent access to extension services enhances the embracing of technologies by smallholder dairy farmers in dairy production for improved milk productivity [58]. Some of the technologies in dairy production include improved feeds, record keeping, parasite and disease control, breeding, and general animal management [58,59]. Table 4 indicates that the animal husbandry practices where most smallholder dairy farmers occasionally sought information were parasite and disease control (51.7%), breeding (45%), breed selection (38.3%), feeding, and feed preparation (36.7%), respectively. Breeding, parasite, and disease control are central to an animal's health and productivity [59]. Animals' productivity is enhanced by adopting improved breeds and controlling diseases and parasites. Higher contact frequency with extension officers is perceived to improve farmers' adoption of dairy production technologies [60]. Additionally, the breeding technique adopted, such as Artificial insemination (AI), bull mating, and the selection of quality cow breeds, affect milk productivity [60]. Adopting these dairy production technologies is very important to smallholder dairy farmers who want to maximize their animals' productivity.

These results corroborate with Okello et al. [59] findings that farmers are likely to adopt such technologies since they are incentives for improved milk productivity and higher incomes for farmers. Table 4 further shows that watering, record keeping, and milking were among the leading areas where farmers never sought information. Low interest in record-keeping, milking, and watering might be due to the perception that these practices do not impact milk productivity in any way [61]. Most farmers also rely on their tacit knowledge, which seems effective over the years, discouraging them from adopting newly recommended technologies such as record-keeping and milking [62]. These findings agree with studies conducted in Ireland and Malawi, where inadequate record-keeping by farmers was due to a lack of understanding of its importance to an animal's health and milk productivity [63]. For cowshed construction and maintenance, low adoption of cow comfort practices was due to a lack of funds to build high-quality cowshed structures. Also, most smallholder dairy farmers in Africa do not invest much in animal housing because most animals sleep outside or in makeshift structures [46,47]. This culture could explain farmers' reluctance to seek information on cowshed construction and management because they do not consider it very important in milk productivity.

3.3. Frequency of applying animal husbandry practices

The third indicator for determining access to extension service**s** was the documentation of the frequency of application of the isolated animal husbandry practices. To determine the frequency of application, the smallholder dairy farmers in Njoro Sub-County were asked to rate their frequency of application of various animal husbandry practices, where **Never** was (0 times), **Rarely** (1–2 times), **Occasionally** (3–4 times), **Often** (5–6 times) and **Very often** (more than 6 times) quarterly. Frequencies and percentages of smallholder dairy farmers who applied the various animal husbandry practices are presented in Table 5.

Table 5 provides the descriptive statistics for the frequency of application of the listed animal husbandry practices. From Table 5 results, the animal husbandry practices where most smallholder dairy farmers never applied the recommendations by experts included

Table 4
Frequency of access to information on animal husbandry practices.

	Smallholder dairy farmers (n = 120), F=Frequency									
	Frequency of access to information on animal husbandry practices									
Animal husbandry practices	Never		Rarely		Occasionally		Often		V/often	
	F	%	F	%	F	%	F	%	F	%
Breed selection	15	12.5	42	35.0	46	38.3	11	9.2	6	5.0
Feed preparation	10	8.30	37	30.8	44	36.7	23	19.2	6	5.0
Feeding	11	9.20	36	30.0	44	36.7	23	19.2	6	5.0
Watering	32	26.7	36	30.0	30	25.0	14	11.7	8	6.7
Parasite control	3	2.50	31	25.8	62	51.7	13	10.8	11	9.2
Disease control	4	3.30	32	26.7	62	51.7	13	10.8	9	7.5
Cowshed maintenance	25	20.8	43	35.8	42	35.0	6	5.0	4	3.3
Breeding	13	10.8	40	33.3	54	45.0	8	6.7	5	4.2
Milking	26	21.7	38	31.7	38	31.7	13	10.8	5	4.2
Record keeping	26	21.7	40	33.3	33	27.5	12	10.0	9	7.5

Table 5
Frequency of applying animal husbandry practices.

Animal husbandry practices	Smallholder dairy farmers (n = 120), F=Frequency									
	Frequency of applying animal husbandry practices									
	Never		Rarely		Occasionally		Often		Very often	
	F	%	F	%	F	%	F	%	F	%
Breed selection	16	13.3	37	30.8	49	40.8	14	11.7	4	3.3
Feed preparation	8	6.7	50	41.7	32	26.7	18	15.0	12	10.0
Feeding	2	1.7	34	28.3	32	26.7	28	23.3	24	20.0
Watering	2	1.7	7	5.8	9	7.5	30	25.0	72	60.0
Parasite control	1	0.8	21	17.5	50	41.7	29	24.2	19	15.8
Disease control	1	0.8	23	19.2	50	41.7	27	22.5	19	15.8
Cowshed maintenance	33	27.5	52	43.3	23	19.2	5	4.2	7	5.8
Breeding	8	6.7	25	20.8	66	55.0	13	10.8	8	6.7
Milking	14	11.7	24	20.0	27	22.5	26	21.7	29	24.2
Record keeping	57	47.5	24	20.0	8	6.7	7	5.8	24	20.0

record keeping (47.5%), cowshed maintenance (27.5%), and breed selection (13.3%). Adoption of record keeping is perceived to vary across farmers depending on the number of cows reared and breeding techniques used [64]. For instance, farmers with more than three cows using AI keep records to track their animals' conception [64].

Farmers' biases toward keeping specific types of records over others signify that they are unaware of the value of keeping all animal health records [64]. The attitude could explain why 47.5% of the smallholder dairy farmers never kept records. Animal housing is vital for disease control, security, and high production comfort. However, investing in quality housing remains challenging for most smallholder dairy farmers. In Bangladesh, most farmers use tin and straw sheds or half buildings, while those who cannot afford to construct structures keep their cows in open yards [65]. Lack of finances often hinders farmers from building quality cowshed structures. Therefore, farmers use readily available materials to build structures that shelter their animals from direct sunlight and rain.

Table 5 also reveals that watering (60%), milking (24.2%), and feeding (20%) were the animal husbandry practices that smallholder dairy farmers applied very often. Water and feeds were provided to the dairy cows throughout the day by a majority of the smallholder dairy farmers to increase milk yields. Dairy cows usually record high milk productivity when provided with ad-libitum water and feeds [66]. The smallholder dairy farmers who applied the recommended milking techniques attributed it to reduced cases of mastitis. The application of effective milking techniques supports Muturi [67] in that adopting hygienic milking practices, and teat dipping after milking prevents the spread of mastitis. Those who stuck to the conventional milking methods argued that the recommended milking practices were tedious and time-consuming, especially when milking several cows.

3.4. Access to veterinary services

The **fourth indicator** for determining the influence of access to extension services was access to veterinary services from designated institutions. The smallholder dairy farmers were asked to indicate their access to various veterinary services, including; Vaccination, disease diagnosis, deworming, pregnancy diagnosis, breeding, and treatment. The data in Table 6 shows frequencies and percentages of the smallholder dairy farmers who received the listed veterinary services.

From Table 6, vaccination was the government's leading veterinary service to smallholder dairy farmers (50.80%), followed by private (36.70%). Most governments often intervene during animal disease outbreaks to contain the spread of disease and minimize animal deaths. For instance, the Kenyan Government usually provides animal vaccination, especially during outbreaks of diseases such

Table 6
Frequency of access to veterinary services.

Veterinary providers	Smallholder dairy farmers (n = 120), F=Frequency, R/Institutions = Research Institutions, F/groups = Farmer groups, Govt = Government											
	Access to veterinary services											
	Vaccination		Disease diagnosis		Deworming		Pregnancy diagnosis		Breeding		Treatment	
	F	%	F	%	F	%	F	%	F	%	F	%
None	4	3.30	6	5.0	5	4.2	19	15.8	5	4.2	0	0.0
Government	61	50.80	17	14.2	9	7.5	6	5.0	9	7.5	9	7.5
NGOs	0	0.00	1	0.8	0	0.0	0	0.0	0	0.0	1	0.8
Saccos	0	0.00	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
Private	44	36.70	90	75.0	102	85.0	93	77.5	103	85.8	108	90.0
R/institutions	0	0.00	1	0.8	0	0.0	0	0.0	1	0.8	0	0.0
Universities	0	0.00	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
F/groups	0	0.00	2	1.7	1	0.8	0	0.0	0	0.0	0	0.0
Govt& Private	11	9.20	3	2.5	2	1.7	2	1.7	2	1.7	2	1.7

as East Coast Fever (ECF) and Foot and Mouth, through extension and veterinary officers [68]. As much as Government extension providers have been mandated with extension provisions to farmers due to few government extension officers, these services have been privatized [59]. The emergence of private entities in veterinary service provision is in Table 6, where private entities dominated disease diagnosis, deworming, pregnancy diagnosis, breeding, and treatment at 75%, 85%, 77.5%, 85.8%, and 90%, respectively. The supremacy is due to the availability of private veterinary officers and the quality and promptness of service delivery.

In Kenya, most farmers do not consider most public veterinary services reliable [13]. This undependability is due to high animal non-conception rates and slow responsiveness by veterinary officers. This challenge is mainly due to understaffing, which leads to the loss of farm animals to diseases and other health-related complications [13]. Business-oriented private veterinary providers strive to maintain their clientele by providing efficient and quality services. Therefore, farmers prefer private services to public ones due to the quality of services despite the high charges [69]. These findings are reinforced by Okello et al. [70] that farmers preferred private veterinary services to public ones due to the veterinary officers' availability and quality of services provided to farmers.

3.5. Regression test results between frequency of access to extension services from designated sources and milk productivity

To obtain the linear regression on the frequency of access to extension services and milk productivity, the study documented the frequency of access to extension services from the designated sources. The frequency of access was quoted as follows: Never was given a score of 0; rarely was given a score of 1; occasionally was given a score of 2; often was given a score of 3; and very often was given a score of 4. From the ratings, composite data were generated for use in determining the influence of frequency of access to extension from various sources and milk productivity. The first step was determination of score for farmers in each selected source of extension services. Second step was dividing the score for each farmer by the number of items, providing the average for each farmer. The third step was adding the averages of the 120 farmers to get the total of the averages for all the farmers. The fourth step involved dividing the total averages by the total number of farmers. The resultant data provided composite data.

The composite data represented the extent of frequency of access to extension services. The composite data were then used in the statistical test to determine the influence of frequency of access to extension services on milk productivity in Njoro Sub-County. The results of the statistical tests are presented in Table 7.

Table 7 shows that the R^2 was 0.710, demonstrating that the frequency of access to extension services predicted 71% of milk productivity. The remaining 29% could be due to other factors affecting milk productivity. The analysis generated a p-value less than 0.05, which implied that the frequency of access to extension services had a statistically significant influence on milk productivity. Frequent access to extension services increases the chances of adopting dairy production techniques such as AI, deworming, and improved feeds [9]. The adoption of such technologies improves milk productivity.

This finding concurs with Minten et al. [71] that variations in sources of extension information in Ethiopia led to differences in milk yields. For instance, the varying distances to sources of information, such as government officers, force farmers to stick to conventional methods or seek advice from friends and neighbours whose inputs might not improve milk productivity. Contrarily, a study in Ethiopia by Berhane et al. [72] on the state of agricultural extension on agricultural productivity showed that the sources of extension services did not matter but rather the adoption of new technologies and innovations that enhance productivity.

3.6. Regression test results between frequency of receiving information on animal husbandry practices and milk productivity

To obtain the linear regression on the frequency of receiving information on animal husbandry practices and milk productivity, the study documented the frequency of access to various animal husbandry practices. The frequency of access was quoted as follows: Never was given a score of 0; rarely was given a score of 1; occasionally was given a score of 2; often was given a score of 3; and very often was given a score of 4. From the ratings, composite data were generated for use in determining the influence of frequency of receiving information on animal husbandry practices from various sources on milk productivity. The first step was determining the score for farmers in the selected animal husbandry practices. The second step was dividing the score for each farmer by the number of items, providing the average for each farmer. The third step was adding the averages of the 120 farmers to get the total averages for all the farmers. The fourth step involved dividing the total of averages by the total number of farmers. The resultant data provided composite data.

The composite data represented the extent of the frequency of receiving information on animal husbandry practices. The composite data were then used in the statistical test to determine the influence of the frequency of receiving information on animal husbandry practices on milk productivity in Njoro Sub-County. The results of the statistical tests are in Table 8.

Table 8 reveals that the R^2 output of 0.120 indicated that the frequency of receiving information on animal husbandry practices

Table 7
Regression test results between frequency of access to extension services from designated sources and milk productivity.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	−6.859	1.203	.843	−5.701	.000
Frequency of access to extension services from designated sources	9.008	.529		17.015	.000

$R^2 = 0.710$, $p < 0.05$.

Table 8
Regression test results between the frequency of receiving information on animal husbandry practices and milk productivity.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	5.146	2.030	.346	2.535	.013
Frequency of receiving information on animal husbandry practices	.326	.081		4.007	.000

$R^2 = 0.120$, $p < 0.05$.

predicted 12.0% of milk productivity. The remaining 88.0% are due to other factors affecting milk productivity. The analysis generated a p-value of less than 0.05, showing that the frequency of receiving information on animal husbandry practices had a statistically significant influence on milk productivity.

3.7. Regression test results between frequency of applying animal husbandry practices and milk productivity

To obtain the linear regression on the frequency of applying information on animal husbandry practices and milk productivity, the study documented the frequency of application of various animal husbandry practices. The frequency of application was quoted as follows: Never was given a score of 0; rarely was given a score of 1; occasionally was given a score of 2; often was given a score of 3; and very often was given a score of 4. The ratings generated composite data to determine the influence of frequency of applying information on animal husbandry practices from various sources on milk productivity. The first step was determining the score for farmers in each selected animal husbandry practice. Second step was dividing the score for each farmer by the number of items, providing the average for each farmer. The third step was adding the averages of the 120 farmers to get the total of the averages for all the farmers. The fourth step involved dividing the total of averages by the total number of farmers. The resultant data provided composite data.

The composite data represented the extent of the frequency of applying information on animal husbandry practices. The composite data were then used in the statistical test to determine the influence of the frequency of applying information on animal husbandry practices on milk productivity in Njoro Sub-County. The results of the statistical tests are in Table 9.

The findings in Table 9 indicate that the R^2 output of 0.165 implied that the frequency of applying animal husbandry practices predicted 16.5% of the variation in milk productivity, while the remaining 83.5% could be due to other factors affecting milk productivity. Table 8 also shows that $p < 0.05$ indicates that the frequency of applying animal husbandry practices had a statistically significant influence on milk productivity.

The findings in Table 9 show that frequent application of animal husbandry practices positively impacted milk productivity. The findings align with Shija et al. [73], who argued that maintaining animal management practices such as quality housing, adequate watering, quality feeding, and cattle upgrading through adopting improved breeds in Tanzania improved their productivity. Adherence to animal husbandry practices ameliorate dairy cows' heat stress and feed scarcity and helps better manage diseases, improving their milk yields [73]. Similarly, improved animal genetics and consistent animal management practices improved milk production in Senegal. However, despite acquiring knowledge of the importance of animal husbandry practices, most smallholder dairy farmers may not adopt them frequently, as evident in Ethiopia and Kenya, due to financial constraints [74].

3.8. Regression test results between access to veterinary services and milk productivity

The study documented the veterinary services to obtain the linear regression on access to veterinary services and milk productivity. The access to veterinary services was rated as follows, access = 1, no access = 0. From the ratings, composite data were generated for use in determining the influence of access to the various veterinary services on milk productivity. The first step was determination of score for farmers in each selected veterinary service. Second step was dividing the score for each farmer by the number of items, providing the average for each farmer. The third step was adding the averages of the 120 farmers to get the total of the averages for all the farmers. The fourth step involved dividing the total of averages by the total number of farmers. The resultant data provided composite data.

The composite data represented access to veterinary services. The composite data were then used in the statistical test to determine the influence of access to veterinary services on milk productivity in Njoro Sub-County. The results of the statistical tests are in Table 10.

Table 9
Regression test results between the frequency of applying animal husbandry practices and milk productivity.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	2.600	2.212	.406	1.175	.242
Frequency of applying animal husbandry practices	3.428	.709		4.832	.000

$R^2 = 0.165$, $p < 0.05$.

Table 10
Regression test results between access to veterinary services and milk productivity.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	4.569	4.070	.190	1.123	.264
Access to veterinary services	8.936	4.262		2.097	.038

$R^2 = 0.036$, $p < 0.05$.

The R^2 value in Table 10 shows that access to veterinary services accounted for 3.6% of the variation in milk productivity in Njoro Sub-County, Nakuru County, Kenya. The remaining 96.4% are due to other factors affecting milk productivity. The p-value, less than 0.05, supported the results, signifying a statistically significant influence of access to veterinary services on milk productivity.

The results in Table 10 show that access to veterinary services had a statistically significant influence on milk productivity. The findings agree with a study conducted in Swaziland, where poor-quality veterinary services led to low milk productivity and profitability among smallholder dairy farmers [5]. The results in Table 10 also support the findings by Shija et al. [73], where regular consultation with professional veterinary services meant higher investment in preventive than curative health, translating to healthy and productive dairy cows [73]. In Uganda, households that accessed quality veterinary services adopted improved dairy technologies that boosted their animals' milk productivity [75]. Similarly, dairy farmers who frequently participated in animal husbandry training in Ethiopia had higher chances of receiving veterinary services since inclusion in training programs targeted farmers experiencing animal health problems [76]. The inclusion in the training of smallholder dairy farmers resulted in healthy and productive animals.

3.9. Hypotheses test results

Based on the study's objective, which was "To determine the influence of access to extension services on milk productivity among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya", the following hypothesis was generated.

H01. There is no statistically significant influence of access to extension services on milk productivity among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya".

To test the hypothesis, the study documented and analyzed: Frequency of contact with extension service providers; frequency of receipt of information on animal husbandry practices; and frequency of application of animal husbandry practices. Frequency of contact with extension service providers was rated as follows: **Never**, at 0; **Rarely**, at 1; **Occasionally**, at 2; **Often,** at 3; and **Very often**, at 4. Similar ratings were, also, applied on the frequency of receipt of information on animal husbandry practices **Never** was rated, at 0; **Rarely** was rated, at 1; **Occasionally**, at 2; **Often**, at 3; and **Very often**, at 4. and frequency of application of animal husbandry practices was rated as follows: **Never**, at 0; **Rarely**, at 1; **Occasionally**, at 2; **Often**, at 3; and **Very often**, at 4. Regarding access to veterinary services access to either vaccination, disease diagnosis, deworming, pregnancy diagnosis, breeding and treatment was rated as **No access** = 0, **Access** = 1.

From the ratings, composite data were generated for use in determining the influence of extension services on milk productivity. The first step was determination of score for group of farmers in each category. Second step was dividing the score for each farmer by the number of items, providing the average for each farmer. The third step was adding the averages of the 120 farmers to get the total of the averages for all the farmers. The fourth step involved dividing the total of averages by the total number of farmers. The resultant data provided composite data.

The composite data represented the extent of access to extension services. The composite data were then used in the statistical test to determine the influence of extension services on milk productivity in Njoro Sub-County. The results of the statistical tests are in Table 11.

Table 11's findings demonstrate that the R^2 value was 0.332, implying that access to extension services predicts 33.2% of milk productivity when all other factors are constant. The remaining 66.8% can be due to other factors affecting milk productivity.

The analysis also generated a p-value <0.05, indicating that access to extension services significantly predicted milk productivity. Access to extension services enables smallholder dairy farmers to access AI services, training on milk value addition, animal husbandry, and feed management that translate to improved milk productivity. The results are similar to findings from a study conducted in Uganda to determine whether access to extension services enhanced milk production among farmers in cooperatives. Those

Table 11
Regression analysis summary on the influence of access to extension services on milk productivity combined.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	−7. 208	2.677	.576	−2.693	.008
Access to extension services	6.945	.906		7.662	.000

$R^2 = 0.332$, $p < 0.05$.

smallholder dairy farmers trained in Artificial Insemination and agribusiness management improved their fodder formulation and dairy cows' concentrates' administration resulting in increased milk production [77]. Access to extension services, therefore, accounted for 25.5% of the differences in daily milk productivity per cow in Uganda [77]. Access to extension services' effects on milk production was also evident in Dodoma, Tanzania, where decentralization of extension services enabled farmers at the grassroots level to access extension and consequently improved productivity [78]. Access to extension services, therefore, influences milk productivity.

4. Conclusions and recommendations

The study conclusions and recommendations are in line with the following strategic implications.

5. Strategic implications

Language Access: The study's findings suggest that the Kenyan government should focus on tailoring agricultural extension services to be broadcasted on radio and television platforms in local vernacular languages or Kiswahili. This approach addresses the challenge faced by smallholder dairy farmers who may not be fluent in the languages used in existing programs on the *Inooro* and *Chamgei* television platforms. By doing so, the government can reach a broader range of farmers and improve the efficiency with which information is disseminated.

Formation of Local Community Groups: Another strategic implication is the formation of local community groups of smallholder dairy farmers. These organizations can be useful information dissemination, training, and knowledge-sharing channels. Extension officers can easily reach multiple farmers through these organized groups simultaneously, promoting better adoption of recommended agricultural practices and mitigating the risk of misinformation from neighbours and friends.

Emphasize Best Practices: According to the study, farmers tend to stick to their tacit knowledge and convenient practices. As a result, extension officers should emphasize the importance of adopting best practices in animal husbandry, such as record-keeping, recommended milking techniques, and providing quality housing, watering, and feeding. This emphasis can potentially improve farm management and productivity in smallholder dairy farms.

6. Managerial implications

Development of Language-Specific Content: Managers in charge of agricultural extension services should consider the strategic implications of language access. To meet the target audience's language needs, they must ensure that content is developed and broadcasted in local vernacular languages or Kiswahili. Collaboration with language experts and broadcasters may help achieve this goal effectively.

Extension Officer Training: Managers must ensure that extension officers are adequately trained to provide farmers with accurate and up-to-date information. Emphasis on record-keeping and recommended agricultural practices should be part of their training. The emphasis will allow the extension officers to disseminate knowledge and encourage farmers to adopt best practices effectively.

Enhancing Private Extension Services: Given smallholder dairy farmers' trust in private veterinary officers, managers should think about empowering and supporting these organizations. Collaborating with private extension officers and providing them with the required resources can increase farmer satisfaction while improving access to quality veterinary services.

Monitoring and Evaluation: Managers should implement a system to track the effectiveness of the suggested changes and interventions. This includes determining the reach and effectiveness of language-specific extension services, forming and operating community groups, and farmer adoption of best practices. Monitoring and evaluation will aid in refining strategies and enhancing extension service delivery over time.

By addressing these strategic and managerial implications, stakeholders in the agricultural sector can strengthen extension services and promote sustainable and improved practices among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya.

Ethics statement

The study received ethical approval from the NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION under ethics approval number; NACOSTI/P/21/14424.

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Author contribution statement

Prisca Ogola, MSc: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Fredrick Ngesa, PhD; Dickson Lubanga Makanji, PhD: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

Data will be made available on request.

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

List of abbreviations and acronyms

AI Artificial Insemination
CESAAM Centre of Excellence in Sustainable Agricultural and Agribusiness Management
ECF East Coast Fever
FAO Food and Agriculture Organization
GDP Gross Domestic Product
GoK Government of Kenya
KDB Kenya Dairy Board
MoALF Ministry of Agriculture Livestock and Fisheries
NACOSTI National Commission for Science, Technology, and Innovation
NDDPF National Dairy Development Policy Framework
NGOs Non-Governmental Organizations
SACCOs Savings and Credit Cooperatives
SDG Sustainable Development Goal
SPSS Statistical Package for Social Sciences
TBP Theory of Planned Behaviour
UN United Nations
USA United States of America

References

[1] B.A. Shiferaw, J. Okello, R.V. Reddy, Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices, Environ. Dev. Sustain. 11 (3) (Jun. 2009) 601–619, https://doi.org/10.1007/s10668-007-9132-1.
[2] B.T. Anang, S. Bäckman, T. Sipiläinen, Adoption and income effects of agricultural extension in Northern Ghana, Scientific African 7 (1) (2020) 219, https://doi.org/10.1016/j.sciaf.2019.e00219.
[3] A. Waaswa, F. Satognon, Development and the environment: Overview of the development planning process in agricultural sector, in Uganda, J. Sustain. Dev. 13 (6) (Oct. 2020), https://doi.org/10.5539/jsd.v13n6p1. Art. no. 6.
[4] A.R. Chawala, G. Banos, A. Peters, M.G.G. Chagunda, Farmer-preferred traits in smallholder dairy farming systems in Tanzania, Trop. Anim. Health Prod. 51 (6) (Jul. 2019) 1337–1344, https://doi.org/10.1007/s11250-018-01796-9.
[5] Food and Agriculture Organization (FAO), Of the United Nations, World Food and Agriculture - Statistical Yearbook 2021, Rome, 2021, https://doi.org/10.4060/cb4477en [Online]. Available:.
[6] O. Opoola, et al., Current situations of animal data recording, dairy improvement infrastructure, human capacity and strategic issues affecting dairy production in Sub-Saharan Africa, Trop. Anim. Health Prod. 51 (6) (Jul. 2019) 1699–1705, https://doi.org/10.1007/s11250-019-01871-9.
[7] Syngenta, "Agricultural Extension,", Syngenta foundation for sustainable agriculture (2023). https://www.syngentafoundation.org/agricultural-extension. (Accessed 10 January 2023).
[8] M. Farooq, M. Pisante (Eds.), Innovations in Sustainable Agriculture, Springer International Publishing, Cham, 2019, https://doi.org/10.1007/978-3-030-23169-9.
[9] G. Mwanga, F.D.N. Mujibi, Z.O. Yonah, M.G.G. Chagunda, Multi-country investigation of factors influencing breeding decisions by smallholder dairy farmers in sub-Saharan Africa, Trop. Anim. Health Prod. 51 (2) (Feb. 2019) 395–409, https://doi.org/10.1007/s11250-018-1703-7.
[10] A.U. Deen, N. Tyagi, R.D. Yadav, S. Kumar, A.K. Tyagi, S.K. Singh, Feeding balanced ration can improve the productivity and economics of milk production in dairy cattle: a comprehensive field study, Trop. Anim. Health Prod. 51 (4) (May 2019) 737–744, https://doi.org/10.1007/s11250-018-1747-8.
[11] S.A. Migose, B.O. Bebe, I.J.M. de Boer, S.J. Oosting, Influence of distance to urban markets on smallholder dairy farming systems in Kenya, Trop. Anim. Health Prod. 50 (7) (Oct. 2018) 1417–1426, https://doi.org/10.1007/s11250-018-1575-x.
[12] A. Abu Hatab, M.E.R. Cavinato, C.J. Lagerkvist, Urbanization, livestock systems and food security in developing countries: a systematic review of the literature, Food Sec 11 (Apr. 2019) 279–299, https://doi.org/10.1007/s12571-019-00906-1.
[13] I.A. Omondi, K.K. Zander, S. Bauer, I. Baltenweck, Understanding farmers' preferences for artificial insemination services provided through dairy hubs, Animal 11 (4) (2017) 677–686, https://doi.org/10.1017/S1751731116002354.
[14] S.J. Staal, A.N. Pratt, M. Jabbar, Dairy Development for the Resource Poor, Part 2: Kenya and Ethiopia Dairy Development Case Studies, International Livestock Research Institute, Nairobi, Kenya, 2011.
[15] County Government of Nakuru, Nakuru County Integrated Development Plan, Ministry of Agriculture Livestock and Fisheries, Nakuru, 2018, 2018-2022.

[16] Ministry of agriculture, livestock and Fisheries, "sessional paper No, 5 of 2013 on The National Dairy Development policy Towards a Competitive and Sustainable Dairy Industry for Economic Growth in the 21st Century and Beyond," (2013). Jan. 07, 2023. [Online]. Available: https://www.kdb.go.ke/wp-content/uploads/2019/06/National-Dairy-Development-Plan-Sessional-Paper-No-5-of-2013.pdf.

[17] Ministry of Agriculture, Livestock and Fisheries [MoALF], "National Dairy Development Policy," Ministry of Agriculture Livestock and Fisheries, vol. 5, Sessional Paper, Nairobi, Kenya, 2013.

[18] O.B. Kashongwe, B.O. Bebe, J.W. Matofari, C.G. Huelsebusch, Effects of feeding practices on milk yield and composition in peri-urban and rural smallholder dairy cow and pastoral camel herds in Kenya, Trop. Anim. Health Prod. 49 (5) (Jun. 2017) 909–914, https://doi.org/10.1007/s11250-017-1270-3.

[19] C. Odhong', et al., Financing large-scale mitigation by smallholder farmers: what roles for public climate finance? Front. Sustain. Food Syst. 3 (Mar. 2019) 3, https://doi.org/10.3389/fsufs.2019.00003.

[20] B. Salasya, et al., "Quantifying the economic impacts of a policy shift towards legalizing informal milk trade in Kenya," 28 (2019).

[21] K.W. Maina, C.N. Ritho, B.A. Lukuyu, E.J.O. Rao, Socio-economic determinants and impact of adopting climate-smart Brachiaria grass among dairy farmers in Eastern and Western regions of Kenya, Heliyon 6 (6) (Jun. 2020), e04335, https://doi.org/10.1016/j.heliyon.2020.e04335.

[22] A. Waaswa, A.O. Nkurumwa, A.M. Kibe, N.J. Kipkemoi, Communicating climate change adaptation strategies: climate-smart agriculture information dissemination pathways among smallholder potato farmers in Gilgil Sub-County, Kenya, Heliyon 7 (8) (Aug. 2021), e07873, https://doi.org/10.1016/j.heliyon.2021.e07873.

[23] K. Marshall, et al., Net benefits of smallholder dairy cattle farms in Senegal can be significantly increased through the use of better dairy cattle breeds and improved management practices, J. Dairy Sci. 103 (9) (Jun. 2020) 1–21, https://doi.org/10.3168/jds.2019-17334.

[24] Q. Abbas, J. Han, A. Adeel, R. Ullah, Dairy production under climatic risks: perception, perceived impacts and adaptations in Punjab, Pakistan, IJERPH 16 (20) (Oct. 2019) 4036, https://doi.org/10.3390/ijerph16204036.

[25] L.J.S. Baiyegunhi, Z.P. Majokweni, S.R.D. Ferrer, Impact of Outsourced Agricultural Extension Program on Smallholder Farmers' Net Farm Income in Msinga, KwaZulu-Natal, South Africa," *Technology In Society*, vol. 57, May 2019, pp. 1–7, https://doi.org/10.1016/j.techsoc.2018.11.003.

[26] C.O. De Freitas, F. de Figueiredo Silva, M.J. Braga, M. de Carvalho Reis Neves, Rural extension and technical efficiency in the Brazilian agricultural sector, Int. Food Agribus. Manag. Rev. 24 (2) (Mar. 2021) 215–232, https://doi.org/10.22434/IFAMR2020.0094.

[27] F. Mureithi, Nakuru Dairy Farmers Record High Milk Production, Daily Nation, 2019. https://www.nation.co.ke/business/seedsofgold/Nakuru-dairy-farmers-record-high-milk-production/2301238-5248150-lg2yv/index.html. (Accessed 25 February 2020).

[28] J.W.O. Smollo, A.M. Ali-Olubandwa, C.M. Ng'endo, Influence of utilizing animal husbandry information from mobile phones on ilk yield among smallholder dairy farmers in Njoro Sub-County, Kenya, International Journal of Agricultural Extension 4 (1) (2017) 7.

[29] Njoro Sub-County, "Smallholder Dairy Farmers' Access to Veterinary Services." Unpublished, 2020.

[30] G. Pokhariyal, Importance of moderating and intervening variables on the relationship between independent and dependent variables, Int. J. Stat. Appl. Math. 4 (5) (2019) [Online]. Available: https://www.mathsjournal.com/pdf/2019/vol4issue5/PartA/4-4-11-253.pdf.

[31] I. Ajzen, The theory of planned behaviour, Organ. Behav. Hum. Decis. Process. 50 (2) (Dec. 1991) 179–211, https://doi.org/10.1016/0749-5978(91)90020-T.

[32] Kenya National Bureau of Statistics (Ed.), Kenya Population and Housing Census, vol. 1, Kenya National Bureau of Statistics, Nairobi, 2019, 2019.

[33] Faostat, Crops and Livestock Products, Food and Agriculture Organization of the United Nations, 2023. https://www.fao.org/faostat/en/#data/QCL. Aug. 01, 2023.

[34] D. Nassiuma, Survey Sampling Theory and Methods, Nairobi University Press, Nairobi, 2000.

[35] N. Kathuri, D. Pals, Introduction to Education Research, 1993. https://www.google.com/search?q=Kathuri%2C+N.%2C+%26+Pals%2C+D.+(1993).+Introduction+to+education+research.+Education+media+center%3A+Egerton+University.&rlz=1C1NDCM_enKE876KE876&oq=Kathuri%2C+N.%2C+%26+Pals%2C+D.+(1993).+Introduction+to+education+research.+Education+media+center%3A+Egerton+University.&aqs=chrome..69i57.76759j0j7&sourceid=chrome&ie=UTF-8. (Accessed 17 March 2021).

[36] N. Mubangizi, F.B. Kyazze, P.I. Mukwaya, Determinants of strategies that enhance farmers' resilience to rainfall variability in Mt. Elgon region, eastern Uganda, in: Y. Bamutaze, S. Kyamanywa, B.R. Singh, G. Nabanoga, R. Lal (Eds.), Agriculture and Ecosystem Resilience in Sub Saharan Africa: Livelihood Pathways under Changing Climate, Climate Change Management, Springer International Publishing, Cham, 2019, pp. 509–539, https://doi.org/10.1007/978-3-030-12974-3_23.

[37] O.M. Kyambo, Determinants of Adoption of Improved Amaranth Among Small Scale Farmers in Buuri Sub-county, Meru County, Kenya, Egerton University, Njoro, Nakuru, Kenya, 2014 [Online]. Available: http://ir-library.egerton.ac.ke/bitstream/handle/123456789/1412/Determinants%20of%20adoption%20of%20improved%20Amaranth%20among%20small%20scale%20farmers%20in%20Buuri%20Sub-County%2c%20Meru%20County%2c%20Kenya.pdf?sequence=1&isAllowed=y.

[38] H. Taherdoost, Validity and reliability of the research instrument; How to test the validation of a questionnaire/survey in a research, SSRN Journal 5 (3) (2016) 28–36, https://doi.org/10.2139/ssrn.3205040.

[39] A.R. Artino, J.S. La Rochelle, K.J. Dezee, H. Gehlbach, Developing questionnaires for educational research: AMEE Guide No. 87, Med. Teach. 36 (6) (Jun. 2014) 463–474, https://doi.org/10.3109/0142159X.2014.889814.

[40] D.M. Nyaguthii, B. Armson, P.M. Kitala, B. Sanz-Bernardo, A. Di Nardo, N.A. Lyons, Knowledge and risk factors for foot-and-mouth disease among small-scale dairy farmers in an endemic setting, Vet Res 50 (1) (Dec. 2019) 33, https://doi.org/10.1186/s13567-019-0652-0.

[41] J.R. Fraenkel, N.E. Wallen, H.H. Hyun, How to Design and Evaluate Research in Education, eighth ed., McGraw-Hill Humanities/Social Sciences/Languages, New York, 2012.

[42] H. Jumba, H. Kiara, G. Owuor, N. Teufel, Are there gender differences in access to and demand for East Coast fever vaccine? Empirical evidence from rural smallholder dairy farmers in Kenya 121 (2) (Nov. 2020) 219–231, https://doi.org/10.17170/KOBRA-202010191970.

[43] J.S. Tata, P.E. McNamara, Impact of ICT on agricultural extension services delivery: evidence from the Catholic Relief Services SMART skills and Farmbook project in Kenya, J. Agric. Educ. Ext. 24 (1) (Jan. 2018) 89–110, https://doi.org/10.1080/1389224X.2017.1387160.

[44] M. Gatheru, D.M.G. Njarui, E.M. Gichangi, J.M. Ndubi, A.W. Murage, A.W. Gichangi, Status and factors influencing access of extension and advisory services on forage production in Kenya, AJAEES 39 (3) (Apr. 2021) 99–113, https://doi.org/10.9734/ajaees/2021/v39i330550.

[45] J.N. Ng'ombe, M.C. Tembo, B. Masasi, 'Are they aware, and why?' Bayesian analysis of predictors of smallholder farmers' awareness of climate change and its risks to agriculture, Agronomy 10 (3) (Mar. 2020) 376, https://doi.org/10.3390/agronomy10030376.

[46] Y. Mugumaarhahama, et al., Characterization of smallholder cattle production systems in South-Kivu province, eastern Democratic Republic of Congo, Pastoralism 11 (1) (Dec. 2021) 4, https://doi.org/10.1186/s13570-020-00187-w.

[47] M. Villettaz, J. Rushen, A.M. de Passillé, E. Vasseur, K. Orsel, D. Pellerin, Associations between on-farm animal welfare indicators and productivity and profitability on Canadian dairies: I. On freestall farms, J. Dairy Sci. 102 (5) (May 2019) 4341–4351, https://doi.org/10.3168/jds.2018-14817.

[48] A. Waaswa, A. Oywaya Nkurumwa, A. Mwangi Kibe, J. Ngeno Kipkemoi, Climate-Smart agriculture and potato production in Kenya: review of the determinants of practice, Clim. Dev. 14 (1) (Jan. 2022) 75–90, https://doi.org/10.1080/17565529.2021.1885336.

[49] L. Bizikova, et al., A scoping review of the contributions of farmers' organizations to smallholder agriculture, Nat Food 1 (10) (Oct. 2020) 620–630, https://doi.org/10.1038/s43016-020-00164-x.

[50] T. Wossen, et al., Impacts of extension access and cooperative membership on technology adoption and household welfare, J. Rural Stud. 54 (Aug. 2017) 223–233, https://doi.org/10.1016/j.jrurstud.2017.06.022.

[51] R.M. Kahwili, Role of Agro-Dealers in Inputs Distribution and the Counterfeit Challenges to Smallholder Farmers in Tanzania, Sokoine University of Agriculture, Tanzania, 2020 [Online]. Available: http://suaire.suanet.ac.tz/bitstream/handle/123456789/3651/REMIGIUS%20MANFRED%20KAHWILI.pdf?sequence=1&isAllowed=y.

[52] J. Lamontagne-Godwin, F.E. Williams, N. Aslam, S. Cardey, P. Dorward, M. Almas, Gender differences in use and preferences of agricultural information sources in Pakistan, J. Agric. Educ. Ext. 24 (5) (Oct. 2018) 419–434, https://doi.org/10.1080/1389224X.2018.1491870.

[53] H.M. Mwololo, J.M. Nzuma, C.N. Ritho, A. Aseta, Is the type of agricultural extension services a determinant of farm diversity? Evidence from Kenya, Development Studies Research 6 (1) (Jan. 2019) 40–46, https://doi.org/10.1080/21665095.2019.1580596.
[54] G.E. Fischman, M. Ott, Access, equity and quality trends in Latin America's public universities, Int. J. Educ. Dev. 58 (Jan. 2018) 86–94, https://doi.org/10.1016/j.ijedudev.2016.11.002.
[55] S.M. Swanberg, M. Mi, K. Engwall, N. Bulgarelli, Community engagement at an emerging academic medical library: a three-pronged outreach model, Med. Ref. Serv. Q. 37 (3) (Jul. 2018) 234–248, https://doi.org/10.1080/02763869.2018.1477707.
[56] E.M. Emeana, L. Trenchard, K. Dehnen-Schmutz, The revolution of mobile phone-enabled services for agricultural development (m-Agri services) in Africa: the challenges for sustainability, Sustainability 12 (2) (Jan. 2020) 485, https://doi.org/10.3390/su12020485.
[57] D.O. Okello, Effect of ICT Use on Performance of Agrienterprises. A Case of Smallholder Pineapple Farmers in Kiambu County, Kenya," Master Thesis, Egerton University, Njoro, Kenya, 2017 [Online]. Available: http://ir-library.egerton.ac.ke/jspui/bitstream/123456789/1906/1/Effect%20of%20ICT%20use%20on%20performance%20of%20Agri-enterprises.%20A%20case%20of%20smallholder%20pineapple%20farmers%20in%20Kiambu%20County%2C%20Kenya.pdf.
[58] S. Abbasi, K. Nawab, Determinants of the dairy technology adoption by the rural milk producers in district muzaffarabad, azad Jammu and Kashmir, SJA 37 (3) (2021) 921–929, https://doi.org/10.17582/journal.sja/2021/37.3.921.929.
[59] C. Larochelle Okello, E. Gathungu, P. Mshenga, G. Owuor, Determinants of utilization of agricultural technologies among smallholder dairy farmers in Kenya, Journal of Agriculture and Food Research 6 (Dec. 2021), 100213, https://doi.org/10.1016/j.jafr.2021.100213.
[60] M. Ashfaq, R. Kousar, M.S.A. Makhdum, J. Nasir, Empirical analysis of livestock productivity through improved breeding in Punjab, Pakistan, THE JAPS 30 (6) (Aug. 2020), https://doi.org/10.36899/JAPS.2020.6.0185.
[61] D. Chiumia, T.N. Gondwe, L.J. Banda, S.N. Sivaselvam, S.E. Ulbrich, M.G.G. Chagunda, Enhancing knowledge exchange and performance recording through use of short messaging service in smallholder dairy farming systems in Malawi, Cogent Food Agric. 6 (1) (Jan. 2020), 1801214, https://doi.org/10.1080/23311932.2020.1801214.
[62] R.P. Deka, U. Magnusson, D. Grace, T.F. Randolph, R. Shome, J.F. Lindahl, "Estimates of the economic cost caused by five major reproductive problems in dairy animals in Assam and Bihar, India,", Animals 11 (11) (Oct. 2021) 3116, https://doi.org/10.3390/ani11113116.
[63] L. Balaine, E.J. Dillon, D. Läpple, J. Lynch, Can technology help achieve sustainable intensification? Evidence from milk recording on Irish dairy farms, Land Use Pol. 92 (Mar. 2020), 104437, https://doi.org/10.1016/j.landusepol.2019.104437.
[64] G. Mwanga, F.D.N. Mujibi, Z.O. Yonah, M.G.G. Chagunda, Multi-country investigation of factors influencing breeding decisions by smallholder dairy farmers in sub-Saharan Africa, Trop. Anim. Health Prod. 51 (2) (Feb. 2019) 395–409, https://doi.org/10.1007/s11250-018-1703-7.
[65] A. Ruhul, Md Ahsanul Kabir, S.M. Jahangir Hossain, G. Kumar Deb, S. Muhammad Amanullah, F. Afroz, Study on existing husbandry management practices of cattle rearing in selected areas of Bangladesh, Int. J. Artif. Intell. Expet. Syst. 5 (6) (2020) 279, https://doi.org/10.11648/j.ijae.20200506.16.
[66] A.A. Khaskheli, Dairy cows under the influence of dietary manipulations: a-Review, Anim. Sci. J. 11 (1) (2020) 15–21.
[67] E.W. Muturi, Effect of mastitis on milk production in dairy cows in Kenya, JAH (J. Adolesc. Health) 2 (1) (Nov. 2020) 85–91, https://doi.org/10.47604/jah.1170.
[68] P. Compston, G. Limon, A. Sangula, J. Onono, D.P. King, B. Häsler, Understanding what shapes disease control: an historical analysis of foot-and-mouth disease in Kenya, Prev. Vet. Med. 190 (May 2021), 105315, https://doi.org/10.1016/j.prevetmed.2021.105315.
[69] J.O. Onono, B. Wieland, J. Rushton, Factors influencing choice of veterinary service provider by pastoralist in Kenya, Trop. Anim. Health Prod. 45 (6) (Aug. 2013) 1439–1445, https://doi.org/10.1007/s11250-013-0382-7.
[70] G. Owuor Okello, C. Larochelle, E. Gathungu, P. Mshenga, Determinants of utilization of agricultural technologies among smallholder dairy farmers in Kenya, Journal of Agriculture and Food Research 6 (Dec. 2021), 100213, https://doi.org/10.1016/j.jafr.2021.100213.
[71] B. Minten, Y. Habte, S. Tamru, A. Tesfaye, The transforming dairy sector in Ethiopia, PLoS One 15 (8) (Aug. 2020), e0237456, https://doi.org/10.1371/journal.pone.0237456.
[72] G. Berhane, C. Ragasa, G.T. Abate, T. Assefa, The State of Agricultural Extension Services in Ethiopia and Their Contribution to Agricultural Productivity, Oct. 2018. Accessed: Jul. 21, 2022. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S2405844018311757.
[73] D.S. Shija, O.A. Mwai, P.K. Migwi, R. Mrode, B.O. Bebe, Characterizing management practices in high- and average-performing smallholder dairy farms under contrasting environmental stresses in Tanzania, World 3 (4) (Oct. 2022) 821–839, https://doi.org/10.3390/world3040046.
[74] E.G. Kebebe, S.J. Oosting, I. Baltenweck, A.J. Duncan, Characterisation of adopters and non-adopters of dairy technologies in Ethiopia and Kenya, Trop. Anim. Health Prod. 49 (4) (Apr. 2017) 681–690, https://doi.org/10.1007/s11250-017-1241-8.
[75] E.K. Balirwa, E. Waholi, Analysis of market participation behavior among smallholder dairy farmers in Uganda, JAS 11 (3) (Feb. 2019) 109, https://doi.org/10.5539/jas.v11n3p109.
[76] W.G. Seble, K. Satoko, K. Toshihisa, T.N. Randrianantoandro, H. Kono, Impact of training of small-scale dairy farmers on milk production and income in Ethiopia, jae 24 (3) (Aug. 2020) 1–8, https://doi.org/10.4314/jae.v24i3.1.
[77] N.B. Arinaitwe, B.S. Angubua, Do extension services influence milk production among dairy farmers' cooperatives? IntJ AgriExtension Rural DevStu 6 (3) (2019) 11.
[78] Z.S. Masanyiwa, S.J. Mdachi, B.M.L. Namwata, J.G. Safari, Decentralisation by devolution and farmers' access to agricultural extension services in dodoma, Tanzania, AJAS (Asian-Australas. J. Anim. Sci.) 10 (1) (Feb. 2019) 1–8, https://doi.org/10.19026/ajas.10.5982.