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Access and Use of Information by Smallholder Dairy Farmers: A Case Study of Meru and Uasin Gishu Counties, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author SNM coordinated the study and was involved in statistical analysis and wrote the first manuscript. Author VM designed the study and performed the statistical analysis. Authors DY, DN and MM were involved in the design of the study. All authors read and approved the final manuscript.

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ABSTRACT

Dairy in Kenya is a major source of employment, with smallholders contributing more than 70 percent of gross marketed milk production. Dairy marketing is dominated by the informal sector where raw milk is sold directly to consumers, suggesting low use of technical know-how to improve production as well as quality and safety of milk. The study therefore was conducted to understand the level of information on dairy, as well as determine factors influencing the awareness of dairy standards among smallholder dairy farmers in Meru and Uasin Gishu counties in Kenya. A random sample of 273 households was selected and personal interviews conducted. Data were entered and analysed by use of the Statistical Package for Social Scientists (version 20). Descriptive statistics by use of percentages, and a logistic regression model were used to analyse data. The results depict a low level of information on quality and safety of milk, and the regulatory institutions in Kenya had limited influence on improved milk production, quality and safety. Farmers with marketing contracts,

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those with an upgraded value chain were more likely to access information, while older farmers were less likely to access the information. In order to increase complicity with the regulations, regulatory institutions should increase awareness on the potential benefits of adhering to dairy standards. Farmers should be registered and enter contracts with buyers, and older farmers targeted to provide information. Research and development organisations should make farmers aware so that farmers can demand for information and lobby for services from government institutions.

Keywords: Smallholder; dairy; quality; safety; standards.

1. INTRODUCTION

The dairy sub-sector is one of the most important sub-sectors in Kenya, with a huge potential to alleviate poverty because it is a major source of employment, income and nutrition security for the rural population. There are more than one million smallholder dairy farmers, contributing more than 70% of the gross marketed production from dairy farms in Kenya [1]. Milk is part of the farm produce that generates cash on a regular basis and one of major source of nutrition consumed in large quantities by almost all Kenyans of all ages [2]. According to [1] in Kenya dairy sub-sector employs nearly one million people engaged in farm level dairy activities, processing sector and dairy marketing; distributed into 841,000, 15,000 and 40,000 full-time jobs respectively.

Dairy marketing in Kenya is dominated by the informal sector which collects raw milk from farmers and sells it in raw form directly to consumers. According to [3] milk yield is extremely low, with some countries in Africa recording as low as 174 kg/cow/year compared to over 12,000 kg/cow/year produced in developed countries. A study on food safety risk analysis conducted in Tanzania showed that milk marketed by smallholders directly to consumers or through intermediaries had unacceptably high numbers of bacteria [4]. The probability of consuming milk containing *bacillus cereus*, a toxin producing pathogen, was as high as 22%. These studies illustrate low use of improved technical know-how to improve quality and safety of milk. A study by [5] examined trends in cow productivity and performance from 2000-2010 and found that the costs of concentrates were very high and recommended that one way of increasing gross margins is for smallholder dairy farmers to acquire information to increase feed efficiency.

There is high emphasis on the three primary factors of production being land, labour and capital with little attention to information as a fourth factor to combine the first three factors of production. According to [6], proper use of information gives the highest marginal productivity. Improving information access can create strong incentives for behavior change such as increased quality and safety of dairy products. A report by [7] indicates that smallholders in developing countries can play a significant role in competitive value chains, so long as they have the requisite capabilities, profitable opportunities and the information they need to accurately assess their alternatives. In recognition of the empowering role of information, the government of Kenya has made access to information a right for all citizens [8]. Additionally, the government of Kenya developed the Big Four Agenda in 2017 [9], which articulated and prioritized four areas; manufacturing, food security, universal health care and housing, as drivers for economic growth and development. Improving dairy production, marketed volume and product quality will contribute to enhanced food security which is the second pillar of the Big Four Agenda. In addition requirements by regulatory institutions for high product quality and safety standards have created new opportunities for increased dairy products in the east African region. These requirements have been partially met by large milk producers and processors but excludes smallholder dairy farmers, thus excluding the latter from emerging benefits created by the new opportunities in dairy marketing.

Relevant information to enable high adoption of specialized technologies such as those in the dairy production system is imperative because increased consumer income has caused changes in consumer tastes and preferences. Willingness to pay for milk and value added dairy products is influenced by consumer considerations for quality and safety [10]. Consumers and regulatory institutions rate milk and valued added products from small and medium enterprises as of low quality and inferior safety standards, thus reducing demand for local

milk products and increases for imports. Consumers in both conventional and niche markets expect dairy products of high quality and safety with regard to hygienic handling, taste and flavour, shelf-life and packaging [11]. On the other hand, smallholder dairy farmers have challenges in accessing information to address quality and safety.

Dairy farmers in Kenya have different production methods ranging from farmers rearing indigenous cattle with minimal external input (low level of dairy development), to those with improved dairy cattle and surplus milk for sale (high level of dairy development). Farmers with low level of dairy development use minimal external input, low dairy management level and are not commercially oriented. On the other hand, high level of dairy development have farmers with improved dairy cattle, modern technologies (improved feed, housing, breeding, disease control) therefore get high milk production for sale and for value addition. Farmers with surplus milk for sale either sell individually or through groups and cooperatives. Marketing groups give higher bargaining power to farmers therefore fetch higher prices, and farmers who add value to milk reduce losses (especially during periods of glut) and also fetch higher prices. Commercial oriented farmers aware of standards in dairy (level of hygiene, labelling, packaging) reduce chances of milk being rejected at the point of sale, therefore have more income. The characteristics of all these dairy farmers, the type, level and sources of information are determined in this study with a view to getting intervention measures to improve dairy in the study areas. Different factors that affect the farmer's awareness level of information in dairy include personal characteristics, dairy activities on the farm and farmer's level of production and marketing. Identification of these factors will highlight areas of intervention in order to increase the farmer's level of knowledge in dairy.

The overall objective of the current study was to understand the extent to which dairy farmers use information on dairy as well as determine factors influencing the awareness of dairy standards among smallholder dairy farmers in Meru and Uasin Gishu counties in Kenya. The specific objectives were to: (a) Determine the type, access and use of information by smallholder dairy farmers (b) Determine factors influencing the awareness level of improved dairy management information among smallholder dairy farmers (c) Give recommendations for increased access to information by smallholder dairy farmers.

2. METHODOLOGY

2.1 Study Area

Meru and Uasin Gishu counties were purposively selected based on a baseline survey conducted in 2011 by the Eastern Africa Agricultural Productivity Project Coordinating Unit, Kenya. The survey showed that the two counties had a competitive advantage in dairy production and technology was available to scale up production.

Meru County is located along the eastern side of the Mt. Kenya. It borders Isiolo County to the North and North East, Tharaka County to the South West, Nyeri County to the South West and Laikipia County to the West. According to [12], it has a land area of 5127 km2, a population of 1,535,635, a population density of 299.5 km2 and a poverty rate of 15%.

Uasin Gishu County lies in the midwest of Rift Valley and borders six counties namely Elgeyo-Marakwet County to the East, Trans Nzoia County to the North, Kericho County to the South, Baringo County to the South East, Nandi County to the South West and Bungoma County to the West. It covers an area of 3,345.2 km2 with temperatures ranging from a minimum of 8.40C to a maximum of 270C. It has two rainy seasons with rainfall ranging from 900mm to 1,200mm per annum. It has a population of 894,179 [13] and a population density of 267 people per km2. Statistics show that 50% of the population live below the poverty line. The main agricultural activities are maize, wheat, beef and dairy farming.

2.2 Sample Size

Data were collected from three sub-counties of Meru County: Meru South, Imenti South and Imenti North. In Uasin Gishu County, data were collected from three sub-counties: Wareng, Eldoret West and Eldoret East. The areas were purposively selected because most farmers had dairy as their main farm enterprise. The sampling frame was obtained from the Ministry of Agriculture Livestock and Fisheries of dairy farms. The required sample size was arrived at using the following formula [14]:

$$n = \frac{(z^2)(P)(1-p)}{e^2}$$

Where p is the proportion of the population of interest. In this case it is the proportion of the population participating or not participating in dairy. In the current study we used a value of 0.5. With a 95% confidence level, Z had a value of 1.96, e is the acceptable margin of error (5% in this case). The sample size was therefore calculated as follows:

$$\frac{(1.96^2)\,(0.5)\,(0.5)}{(0.06^2)} = 266$$

A random sample of 266 households was therefore selected and a proportionate allocation of 141 for Meru County and 125 for Uasin Gishu County was made. An additional seven respondents from a group of disabled people from Wareng sub-county in Uasin Gishu County was purposively included making a total of 273 respondents.

2.3 Data Collection

Enumerators were trained for one day and the structured questionnaire pretested and corrections made after the pretest to improve understanding of the questionnaire and the ease of asking questions.

Using the structured questionnaire, enumerators conducted household interviews through the random and systematic sampling method. For each sub-county, sketches were made with help from administration officers. From a central existing land mark (schools, churches, mosques, streams, shopping centres, large trees, roads, footpaths), eight transects were drawn in directions similar to the compass: E,W,N,S, NE,NW,SE,SW. Each transect stretched to a maximum distance of 2 km. Farmers were randomly sampled from the left and right hand side as follows: household one and two on the left were interviewed followed by three and four on the right, five and six on the left, seven and eight on the right, alternating until the end. If the required number of farmers was not achieved on a particular transect, the enumerator was assigned a new transect.

2.4 Data Analysis

Data were then entered by use of the Statistical Package for Social Scientists (SPSS) and STATA 13 (Version 20), and then cleaned to remove outliers and any other anomalies in the data. For Objective One, data were analysed by descriptive statistics while the logistic regression model was used for Objective Two. A synthesis of the results from the two objectives was used for the third objective.

The logistical regression model is used to predict a binary dependent variable given categorical or continuous explanatory variables ([15,16]). This study theorized that awareness of dairy information would be influenced by institutional, socio-economic and household factors. For example awareness of dairy standards involved a binary outcome where a household would either be aware or not as modelled in equation (1):

$$Yi = Xi* + \varepsilon i \quad (1)$$

Where Yi =1 when a household is aware about standards and (0) if otherwise represents the combined effects of explanatory variables. Mathematically, this is represented as:

$$Prob\ (Yi = 1) = (\beta' Xi) \qquad Prob\ (Y = 0) = 1 - (\beta' Xi) \quad (2)$$

Where Yi = 1 represents a household awareness about standards and (Yi = 0), otherwise. For a logit model, the function F will take a logistic function which uses a cumulative distributive function to estimate P as given by equation 3:

$$Prob\ (Y_i = 1) = \frac{e^{\beta' X}}{1 + e^{\beta' X}}$$
$$Prob\ (Y_i = 0) = 1 - \frac{e^{\beta' X}}{1 + e^{\beta' X}} \quad (3)$$

The empirical model is specified as shown below:

Y=β0+β1educ+β2Formal+β3contractual+β4Easy .buyer +β5Prsve_milk+β6Sell_milk+β7Info_tech+β8Del _speed+β9Tech_use+β10 Age+β11Qty_raw+β12Buyer_cost+β13Farmergr p

Where Y is the dependent variable. The description of the other variables used in the logit model is given in Table 1, showing factors that are likely to influence a farmer to get information on dairy standards. For instance a higher education level of the farmer and a formally registered farmers are factors that influence a farmer to increase level of awareness about dairy standards.

Table 1. Description of the variables used in the Logit Model

Variable	Description	Expected sign
Education level	Education level of household head (0=no formal education, 1=primary, 2=Secondary, 3=tertiary)	+
Formally registered buyer	Dummy (1 if the farmer has a formally registered buyer for milk and 0 if not)	+
Contractual Arrangement	Dummy (1 if the farmer has any contractual marketing arrangements for milk and 0 if not)	+
Easy finding buyer	Dummy (1 if the farmer finds it easy to get buyers for milk and 0 if not)	+
Preserve milk	Dummy (1 if the farmer preserves milk and 0 if not)	+
Sell evening milk	Dummy (1 if the farmer sells evening milk and 0 if not)	+
Information on Technology	Dummy (1= 0 if any member of the household gets any information on technologies in dairy and 0 if not)	+
Delivery speed	Dummy (1 if the farmer delivers the milk timely and 0 if not)	+
Technology use	Dummy (1= 0 if the household uses any technologies in dairy and 0 if not)	+
Age of household head	Number in years of the household head	+
Quantity sold	Quantity of raw milk sold in litres	+
Incur cost	Dummy (1= 0 if a household incurs any cost to get a buyer for milk and 0 if not)	+

3. RESULTS

The mean age of the sampled household heads was 43 (n=273) and about 24% (n=273) of the respondents had a tertiary level of education. The main regulatory institutions were KEBS and the KDB. Farmers were asked whether they were aware of the;

a) Standard procedures of cleanliness during milking and storage of milk (hygiene)
b) Required animal feeds for different types of cattle in the herd (animal feeds)
c) Regulations in place to ensure animal welfare,
d) Required market standards for dairy products
e) Prohibited substances put in milk to increase the shelf-life of fresh milk
f) Measures to be taken for disease control in the herd
g) Required equipment during milking
h) General good agricultural practices in milk and fodder production
i) Registered areas/personnel for AI and veterinary services
j) National body that regulates the quality and safety of milk and its milk products (Kenya Bureau of Standards)

The farmers' awareness level of the different aspects of dairy and standards for milk quality and safety is shown in Fig. 1, which shows that only 20% of farmers (n=54) were aware of the existence of KEBS, 17% were aware about hygiene standards, 15% were aware that adulteration of milk was illegal and only 5% knew about using the right equipment when handling milk.

In Fig. 2 about 16% of the respondents were influenced by the regulatory institutions to control diseases, 14% to improve the quality and safety of milk and 9% and 5% of the respondents were influenced to increase the speed in milk delivery and to acquire improved dairy cattle respectively.

About 66% (n=256) of the respondents had inadequate skills in animal husbandry and 55% (n=253) of them had inadequate information on new technologies. The new technologies explored were those for value addition in milk (yoghurt, sour milk known as mala, cheese and ghee). Over 90% (n=273) of the farmers marketed milk individually in raw form. Markets for raw milk were easily available but 80% (n=194) said they did not fetch good prices, 43% (n=273) had no bargaining power and 63% (n=219) had weak contractual arrangements with buyers.

Information from milk buyers was mainly on costs and prices, new market trends and the available

business services. Only 17% of the respondents reported getting information on market requirements/quality standards from milk buyers. About 64% (n=259) reported that the information received from input suppliers was mainly on the suppliers' products and services, with 23% of them saying that the information received was unreliable.

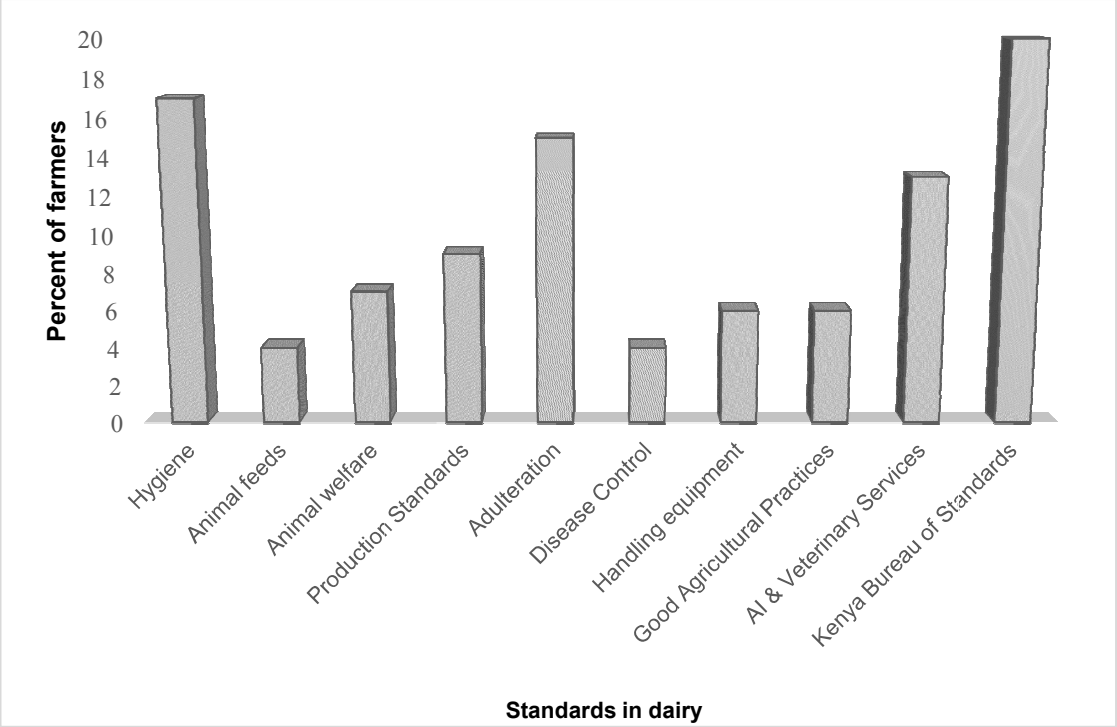

Fig. 1. Proportion of households aware about various standards in the dairy sector in Meru and Uasin Gishu counties

Fig. 2. Proportion of households influenced by regulatory institutions in various dairy activities in Meru and Uasin Gishu counties

Table 2. Factors influencing awareness of dairy standards

Awareness of dairy standards	Coefficient.	Std. Error.	z	P>z
Education level of HH head	0.16	0.19	0.83	0.41
Formally registered buyer	1.42	0.39	3.61	0.00***
Contractual Arrangement	1.06	0.43	2.51	0.01***
Easy finding buyer	0.17	0.49	0.34	0.73
Preserve milk	0.61	0.36	1.67	0.09*
Sell evening milk	0.39	0.34	1.16	0.25
Information on Technology	0.87	0.34	2.49	0.01**
Increased Delivery speed	0.73	0.35	2.09	0.04**
Increased Technology use	0.09	0.33	0.29	0.77
Age of household head	-0.04	0.01	-2.81	0.00***
Quantity sold	0.02	0.01	1.36	0.18
Incur cost	0.28	0.74	0.38	0.70
Belong to farmer group	0.19	0.38	0.49	0.62
Constant	-2.75	0.95	-2.88	0.00

*Logistic regression Level of significance, * 10%, ** 5%, *** 1%. HH-house hold Prob > chi^2 = 0.0000 Log likelihood = -120.24024 Pseudo R^2 = 0.1637 Marginal effects after logit Y = Pr (STDS) (predict) 0.17115934*

About 90% (n=273) of the respondents reported that no member of their family had been trained on value addition activities and the few who were trained obtained it from the government. Thus knowledge on value addition used by households was mainly from other farmers or traditional knowledge. Furthermore, only 26% (n=42) of the respondents funded themselves to get training on value addition while the remaining relied on donors and the government.

Table 2 shows factors that influenced farmers' awareness about the various dairy standards.

Households that delivered milk to a registered processor/buyer and those that had official contractual arrangements with buyers were more likely to be aware of the standards than those with no such arrangements. Registered processors included cooperative societies, registered farmer groups and large processing companies. The registered processors provided avenues for dissemination of crucial information to farmers hence the significant effect on awareness of standards by households that delivered milk to them. Households that preserved milk, those that sought information on new technologies as well as those that delivered milk timely were more likely to be aware of dairy standards than those that did not. In addition, older farmers were less likely to be aware of dairy standards.

The marginal effects from the logit model showed that the combined explanatory variables as specified by the model predicted a 17% likelihood that a farmer would be aware of standards provided that the farmers had similar characteristics.

4. DISCUSSION

The mean age of 43 years for the sampled household heads was lower than the average age of the Kenyan farmer which is 60 years [17], but higher than the maximum age of 35 years for an individual to be considered a youth in Kenya. This therefore leaves out the youth (in the face of high unemployment levels among the youth) in farming yet dairy farming needs the youth because they can easily access information on new technologies.

A study by [18] singled out the importance of education in adoption of information. Education creates new interests, broadens expectations and generates a consciousness of deprivation, thus prompting educated people to seek for ways to improve their condition. The proportion of farmers with tertiary education (at 24%) was low, demonstrating that most farmers had a limited capacity to seek and utilize information.

The low awareness level about standards in the dairy sector recorded in the current study is in accord with [19], who reported that a lack of knowledge on technology was the main constraint to improved dairy production in Machakos and Makueni counties. The low level of information on improved milk production and milk quality and safety was caused by limited influence from regulatory institutions. Farmers mainly interacted with production input suppliers and informal milk buyers and had weak links with

regulators and custodians of quality and safety standards. Informal milk buyers may cause information asymmetry where farmers have limited knowledge about better prices and markets to the advantage of the informal milk buyers. This may encourage farmer exploitation by other players in the dairy value chain and obstruct access to better markets. Informal milk buyers were more concerned with profits than with the quality and safety of milk. A study by [20] concluded that increase of milk quality, level of value addition and access to market information increased the household commercialization index in Uasin Gishu County. Unfortunately, limited funding within regulatory institutions hampers provision of information needed by smallholder farmers ([21]). The mandate given to KDB through the Dairy Industry Act CAP 336 is to regulate, develop and promote the dairy industry [22], while KEBS' mandate, as stated in Standards Act CAP 496 is to regulate, develop and promote the dairy industry [23].

The results show that dairy farmers got limited information from milk buyers. Fresh milk is highly perishable, thus informal milk buyers take advantage of this by offering low prices and giving information that is beneficial to them (buyers). Collective milk marketing will enable collective bargaining for better prices and sound contractual agreements. Additionally, through collective efforts dairy farmers can seek for information on production and value addition.

Results from the logistic regression analysis emphasize the importance of having formal contracts between farmers and milk processors that explicitly communicates the requirements for delivery of a specific dairy product. Formally registered buyers of milk uphold high quality and safety standards in milk, therefore impart the same knowledge to farmers. Preservation of milk needs technologies on value addition, meaning farmers who want to preserve milk should be aware of standards for value addition. Therefore, for a farmer to upgrade the dairy value chain, information on the various dairy standards was indispensable.

The results also show that younger farmers sought for information on dairy to increase their awareness of their dairy standards. In reviewing many studies, [24], found that the influence of age on adoption of agricultural technologies is indeterminate. However [25] found a negative influence of age on adoption of improved rice varieties in Ghana.

5. CONCLUSION

The study set out to determine the type, access and use of information by smallholder dairy farmers, determine factors influencing the awareness level of information among smallholder dairy farmers and give recommendations for increased access to information by smallholder dairy farmers.

The results show that a small proportion of farmers were aware about the required information in dairy. Public institutions, especially KEBS and KDB were the main providers of information but the proportion of farmers influenced by these institutions was very low. Farmers marketed raw milk individually with weak contractual arrangements, thus fetching low prices. In addition information from milk buyers was mainly on other aspects other than information on milk quality and safety. Training on value addition among the surveyed households was low, and few farmers took the initiative to train on value addition.

There was also low level of education among the sampled households, meaning that most farmers would find difficulty in using information. Factors that influenced the awareness of dairy standards were if the farmer had; a formally registered buyer, contractual arrangements, preserved milk, had information on technology use and delivered milk timely. Older farmer were less aware of information on quality and safety.

To increase adherence to regulations on quality and safety of milk KDB and KEBS should enhance dairy farmers' awareness on the potential benefits accrued from adhering to existing dairy standards. Farmers should be trained on suitable methods to increase the safety and quality of milk. Research and development organisations should train farmers to demand for information and lobby for services from government institutions.

In consideration of farmers' low level of education, packaging of information should be simple to read, understand and apply. Extension officers in the counties should urge farmers to have marketing groups for collective marketing of milk to enable higher bargaining power for better prices. Marketing groups will increase farmers' access to information on quality and safety of milk and motivate farmers to train on value addition. Finally extension officers should target older farmers to give them information and at the

same time encourage young farmers to adopt dairy because this category of farmers gets information faster than their older counterparts.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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