FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Effect of ICT tools attributes in accessing technical, market and financial information among youth dairy agripreneurs in Tanzania

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Abstract: The purpose of this article is to determine the effect of Information and communications technology (ICT) tools’ attributes in accessing technical, market and financial information among youthful dairy agripreneurs in Arumeru District, Tanzania. Data were collected through a standardized questionnaire from 347 farming households. Descriptive statistics and multivariate probit regression were used to analyze the data. The results of the study show that utilization of the various ICT tools (mobile phone, television (TV) and radio) is interrelated, whereas several factors, including extension contacts, installation of electricity, level of buyer trust, availability of market information and receiving of remittances, are found to affect the probability of ICT use. Findings also reveal that complementarity, accessibility, relevance and timeliness had a positive effect on ICT use, while the feedback attribute had a negative influence on ICT use. This finding underscores the need to consider ICT tools’ attributes when designing a sustainable ICT-based information delivery model for dairy youth agripreneurs. An understanding of actual users’ preference for ICT attributes can provide a blueprint for the ongoing ICT-based public- and private-sector initiatives that target youth-users more effectively.

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PUBLIC INTEREST STATEMENT

Tanzania is witnessing a gradual increase in adoption of innovative technologies in dairy agrienterprises. As part of the journey towards improving youth employment through agripreneurship. The government and the private sector are making immense efforts in the promotion of ICT use among youthful agripreneurs. This is through access to agricultural information and financial transaction. Despite such initiatives, demand-side issues of usage of these ICT tools are still low. We argue in the paper that uptake and use of ICT tools is a function of socio-economic, institutional and technological attributes, which have not been previously studied. Unless we explore the role of ICT attributes on uptake and use of ICT tools, larger policy level initiatives on dissemination of information using technologies will not be successful. The empirical findings emphasize the importance of considering such factors when designing a sustainable ICT-based information delivery model.
1. Introduction
The necessity of information and communications technology (ICT) tools in agricultural production has become a worldwide phenomenon especially in sub-Saharan African agrienterprises (Hopestone, 2014). The integration of ICT in agricultural production facilitates access to technical and market information that contributes to efficiency improvement and productivity gain along all agricultural value chains (Mwantimwa, 2019). ICT is considered to entice the youth to engage in agribusiness and make agriculture more attractive to them (Nuer, 2018). According to Zhang et al. (2016), youth are receptive to ICT tools use, especially in accessing services and information on farm mapping, mobile banking, weather data, marketing, financial and credit support, input supply, and advice from extension workers.

Through the utilization of ICT, youthful agripreneurs may be able to make more informed daily decisions regarding their agricultural activities leading to improved productivity and profitability, reduced postharvest losses, and increased resilience to the impacts of climate change (Eze & Chinedu-Eze, 2018). Furthermore, in the last two decades, ICT tools have become formidable tools used by many development research, academia and industry practitioners to reach out, as well as disseminate knowledge and expertise to young agripreneurs (Wyche & Steinfield, 2016).

Availability and accessibility of information are paramount for effective and productive dairy production (Ishaq et al., 2017). Youthful dairy agripreneurs need access to information on livestock diseases, nutrition, treatment and control of diseases, breeding techniques, markets for their products, input markets, and financial and credit services (Benard et al., 2019; Mwombe et al., 2014). These dairy agripreneurs may access the information through radio, television (TV) and mobile phones in various forms such as agricultural programs, advertisements, feature stories, agricultural subscription and free SMS services, mobile applications, e-commerce platforms for inputs and produce and videos (Mtega & Msungu, 2013). Some examples of recent ICT-based initiatives that target Tanzanian dairy farmers include Shamba-shape up that airs on radio and TV and also through their website iShamba, iCow that disseminates information through SMSs and through their mobile application and the African Dairy Genetic Gains (ADGG) program that records and disseminates on-form productivity and genetic information through SMS service through partnership with iCow (Marwa et al., 2020).

Efforts to increase the use of ICT in agriculture that would, in turn, increase youth participation in the sector are being promoted by the government. For example, the National Agriculture Policy of 2013, which was implemented by the then Ministry of Agriculture and Cooperative in Tanzania, gives credence to integration of ICT in agriculture (Benard et al., 2019). The policy document gives tax leverages and provides other incentives, such as the building of community information centers with implementing partners that seek to enhance the use, adoption and optimization of ICT agricultural products and services (Barakabitze et al., 2017).

Despite the efforts for ICT development and the availability of these ICT services, the adoption and uptake of ICT in accessing technical, market and financial information among smallholder agripreneurs remains a challenge in Tanzania (Kante et al., 2018). The majority of the studies conducted to explain this low and slow adoption of ICT in agriculture focus on socioeconomic factors (Alavion et al., 2017; Abebe & Mammo Cherinet, 2018; Benard et al., 2019; Fahad et al., 2017; Marwa et al., 2020; Mittal, 2015; Sam, 2016) with limited consideration of the role of the attributes of the available ICT tools as a possible cause. These attributes include
complementarity, accessibility, relevance, timeliness, feedback and portability (Kante et al., 2018; Mtega & Msungu, 2013; Mwombe et al., 2014; Palmer, 2015; Tamubula et al., 2019).

This paper contributes to the body of knowledge by examining the impact of ICT tools’ attributes in accessing technical, market and financial information. Understanding the role of ICT tools’ attributes is crucial as it will inform development and implementation of tailored-made ICT-based programs for dairy youth agripreneurs. Thus, enhancing the uptake of ICT among rural youth dairy agripreneurs. Further contribution to literature is that we have simultaneously modelled utilization of the three main ICT tools (mobile phones, TV and radio) used by majority of rural agripreneurs using the multivariate probit (MVP) model. Previous studies (Fahad et al., 2017; Mittal, 2015; Buys et al., 2009) have considered this relationship in isolation. This approach facilitated the assessment of joint decision-making process of a single dairy youth agripreneur who uses more than one ICT tool at the same time. This paper defines youth agripreneur as anyone aged 18–35 who is involved in dairy farming.

The rest of the paper is organized as follows: Second 2 describes the empirical literature and theoretical framework. Section 3 briefly discusses the material and methods (study area sampling procedure and sample size, instrumentation and data collection procedure, data analysis and estimation of the model). Section 4 provides descriptive and econometric results and discussion. This is followed by the conclusions and policy implications in Sections 5 and 6, respectively.

2. Literature review

2.1. Role of ICT attributes in accessing agricultural information and financial services

According to Tamubula et al. (2019), intention to use ICT for access to information and financial services may be influenced by its complementarity attribute. ICT may be used to complement other extension dissemination methods in the absence of extension agents (Barakabizite et al., 2017). Mtega and Msungu (2013) found that the complementarity of TV, mobile phone and radio positively influenced the use of these ICT tools in Tanzania. Radio and TV were found to be operated in a complementary manner with a TV showing the same program in the evening hours, whereas radio in the early hours of the day. In addition, their study confirmed that the positive effect of complementarity on the intention to use the mobile phone both in information access and mobile money services.

The ease of access of ICT tools is key in enhancing the utilization of ICT in agriculture (Kante et al., 2018). According to Mwombe et al. (2014), accessibility attribute of ICT tools is key in achieving equitable access to information for smallholder farmers. For this transfer to happen, the use of the tools needs to be supported within the farmers’ environment. Deepti et al. (2013) argue that access to and use of accessible technologies are largely determined by the business environment in which they exist and can be improved or hindered by the policies and legislations made by the government and the quality of the service delivery systems and financial models (Sivakumar et al., 2014)

Kante et al. (2018) argued that relevance construct is a key driver in the use of ICT-based farm input information among smallholder farmers. The relevance of ICT tools demands the dissemination of information to farmers, which is correct and necessary. By providing agripreneurs with correct agricultural information, they are able to profitably gain from their agricultural ventures, and this incentivizes youth to engage in the sector (Msoffe & Ngulube, 2016). Failure to provide necessary agricultural information—that is information that is in line with the youth’s environment, skillset and resource endowment—discourages the use of ICT tools in agriculture due to the feeling of non-consideration (Tata & Mnamara, 2018).

The intention to use ICT is highly influenced by its ability to deliver timely agricultural information (Palmer, 2015). Failure to deliver crucial information involving weather patterns, market information, agricultural policies and other expected disasters such as pest and disease outbreaks
timely to farmers leads to the incurring of losses and farmers eventually stop relying on the ICT tools for information as they are deemed unreliable (Macire Kante, 2016). Youths need timely information for them to participate in agriculture (Irungu et al., 2015).

Agripreneurs prefer using ICT tools that provide them with an avenue to air their opinions, ask questions, and, most importantly, get responses to their opinions and inquiries (Palmer, 2015). By getting feedback, farmers are better placed to apply the disseminated information as all their questions and doubts are addressed (Zewge & Dittrich, 2017). The importance of feedback is illustrated in how all agricultural programs in ICT tools have telephone numbers, email addresses and even websites through which farmers can contact them. The portability of ICT tools enables farmers to always have access to agricultural information wherever they may be. This is important, especially in Africa, where due to land segmentation, farms are often located away from houses, and their farmers need a way to access information even when in a field with no electrical connection (Mwombe et al., 2014).

Farmers should not be given unreliable information or of poor quality and difficult to use (FAO, 2014). It is argued that the content of the information delivered should be more important than the mode of delivery (Benard et al., 2019). Therefore, agricultural information providers must guarantee that they broadcast information that satisfies agripreneurs’ needs and is suitable for their agrienterprises (Msoffe & Ngulube, 2016). Moreover, the use of ICT holds considerable potential to make agriculture more attractive to the youth because of their receptiveness to ICT tools, making it easier for them to access dairy information and services. While the use of ICT is generally increasing in the country, there is a dearth of evidence on the role of ICT tools’ attributes in accessing technical, market and financial information in the dairy sector. This study aims to identify the role of ICT tools’ attributes in accessing the technical, market and financial information among youth dairy agripreneurs in Arumeru District, Tanzania.

2.2. Theoretical framework
This study was based on utility maximization theory. This theory assumes that consumers are rational, have limited incomes, have a clear preference for various goods and services and each item has a price tag that consumers have to choose from. The theory postulates that consumers allocate their money incomes on goods and services that give them high utility. In this study, the dairy agripreneurs goals are to choose ICT tools (mobile phones, TV and radio), rationality would be depicted by dairy youth agripreneurs choosing the attainable combination of mobile phones, TV and radio which could yield them high satisfaction in terms of information access and other services. The utility is determined by a set of exogenous variables that influence the choice of using ICT tools. Therefore, the decision to use ICT or not depends on whether an ICT application gives the youth agripreneurs higher utility than without using the ICT tool. The key assumption under this methodology was that youth agripreneurs were faced with only two choices about the utilization of the ICT tools and that any choice an individual chooses depends on their characteristics (Pindyck, 1997). The expected utility difference is as indicated below:

\[ U_j = (\pi^A_j - \pi^0_j) = X_j^A \beta_a + \varepsilon_j \]

where \( U_j \) is the unnoticed anticipation of youth agripreneur signifying the difference in expected utility, \( \pi^A_j \) is the utility resulting from using a given ICT tool \( i \) if chosen by youth agripreneur \( j \), and \( \pi^0_j \) is stream of utility if the youth decides not to use a given ICT tool. The youths then compare utilization and non-utilization of ICT tools in terms of expected utility. They only choose whether to use or not.

\[ Y^A_j = 1 \text{if} \left( \pi^A_j - \pi^0_j \right) \geq 0 \Leftrightarrow X_j^A \beta_a \geq -\varepsilon_j \]

\[ Y^0_j = 0 \text{if} \left( \pi^A_j - \pi^0_j \right) < 0 \Leftrightarrow X_j^A \beta_a < -\varepsilon_j \]
The choice of agripreneur $j$ to use ICT tools $i$ is defined as $Y$ and the decision of agripreneur $j$ to use ICT tool $i$ $Y = 1$ or not $Y = 0$ is stated as follows:

$$Y_i^a = \left\{ \begin{array}{ll} 1 & \text{if} \ Y_i^a = X_i^a Y_j + \epsilon \geq 0 \Rightarrow X_i^a Y_j \geq \epsilon \; \text{and} \\ 0 & \text{if} \ Y_i^a = X_i^a Y_j + \epsilon < 0 \Rightarrow X_i^a Y_j < \epsilon \end{array} \right.$$  

Agripreneurs' $J$'s utility can be expressed as follows:

$$EU_{ij} = \beta_i Z_j + \tau_j$$

$$EU_{mj} = \beta_m Z_j + \tau_m$$

Therefore, this theory was the basis of the study since it is assumed that dairy youth agripreneurs would choose to utilize ICT tools based on the satisfaction they get from access. Youth farmers are rational in decision-making; hence, they would choose to use ICT tools to increase their incomes in their farms.

### 3. Material and methods

#### 3.1. Study area

The study was conducted in Arumeru District (Meru District and Arusha Rural District), which is one of the six districts in the Arusha Region of Tanzania. Arusha District Council administers 3 divisions, 20 wards, 75 villages, 294 hamlets and 64,339 households. Meru District Council administers 3 divisions, 17 wards, 71 villages and 281 sub-villages. The district lies between latitudes of 3°17’–3°27’5 of the Equator and longitudes 35°37’–35°47’ E. It borders Simanjiro District to the east, Hai District to the northwest, Kiteto District to the south and Monduli District to the north. The study area depicts three agro-ecological zones, namely the high-potential areas, the medium-potential areas and the low-potential areas. The high-potential areas are the highlands of Tanzania, which have high altitudes of 1500 m or more above sea level on the eastern slopes of Mount Meru. The majority of dairy agripreneurs are involved in the intensive production of coffee and fruits such as banana, pawpaw and avocado. The choice of the study area was because the majority of small-holder farmers have ventured into commercial dairy farming with intensive use of ICT tools in marketing and accessing agricultural information. This is due to the presence of the ADGG project implemented by the International Livestock Research Institute, which aims to support a farmer-focused partnership that records and disseminates on-farm productivity and genetic information on dairy cattle in Tanzania and Ethiopia through ICT tools in partnership with iCow.

#### 3.2. Data collection

The study used multistage sampling to select the respondents. First, based on information from the District Ward office, eight of the main milk-producing wards were purposively chosen. These wards included Imbaseny, Songora, Nkoranga, Nkoanekoli, Nkoarisambu, Seela, Singisi, Poli and Ambureni. Within the wards, one village was randomly selected, and after that, 347 youth agripreneurs were selected using proportional to size sampling of the wards.

This study used a pretested semi-structured questionnaire as the main instrument for data collection by well-trained enumerators. Prior to data collection, the researcher applied for a research permit from the Tanzania Commission for Science and Technology (COSTECH). Once the permit was approved, the researcher sought approval in the office of Regional Administrative Secretary, Office of the District Administrative Secretary and Office of District Director for final approval and release of information to the respective ward officers. The ward officers, through the help of village leaders, helped in the identification of the respondents’ households.
The respondents were enlightened about the objective of the study and consent was requested from them to participate in the research. They were also reminded that participation in the study was voluntary. Once the respondents gave their consent to participate, they were interviewed using a semi-structured questionnaire. The youth agripreneurs were interviewed on dairy production, marketing parameters and household usage of ICT tools. Key ICT tools of interest were mobile phones, TV and radio, which were identified as the major ICT tools used in the study area (Benard et al., 2019; Msoffice & Ngulube, 2016). The data were collected in January and February 2020.

3.3. Empirical strategy

The objective of the study was to provide empirical evidence on the role of ICT attributes on the choice of ICT tools in Arumeru District, Tanzania. To model the decision to use ICT tools, a univariate binary model (logit or probit) could be appropriate due to the dichotomous nature of the dependent variable (Greene, 2008). Since the estimation was based on several ICT tools, the selection of one or more ICT tools was more likely due to variations of unobserved and unmeasured characteristics of the dairy agripreneurs. In addition, the selection of a single tool may affect the likelihood of selecting other alternatives due to competing, substitutability or complementarity relationship between some ICT tools. Therefore, estimating independent binary equation for each ICT tools would lead to potential bias as it will not allow the correlation of error terms, leading to statistical bias and inefficiency in the estimates (Greene, 2008). To account for such shortcomings, selection decisions were modeled using the MVP model. The MVP model simultaneously regresses a combination of several correlated binary equations against a single vector of explanatory variables. Empirically the model can be specified as shown in Equation (6):

\[ Y_{1i} = X_{1i} \beta_1 + e_{1i} \]

\[ Y_{2i} = X_{2i} \beta_2 + e_{2i} \]

\[ Y_{3i} = X_{3i} \beta_3 + e_{3i} \]

where \( i \) is the youth agripreneur identification, \( Y_{1i} = 1 \), if youth agripreneur uses radio to access agricultural information (0 = otherwise), \( Y_{2i} = 1 \), if youth agripreneur uses TV to access agricultural information (0 = otherwise), \( Y_{3i} = 1 \), if youth agripreneur uses mobile telephony to access agricultural information and to undertake transactions such as marketing produce, mobile banking and mobile money transfers (0 = otherwise), \( X_{1i} = \) a vector of factors affecting the use of ICT tool, \( \beta_j = \) a vector of unknown parameters \( (j = 1, 2, 3) \), and \( e_i = \) is the error term. This estimation strategy was adopted because the decision to use different ICT tools could be correlated. Thus, the elements of error terms might experience stochastic dependence. Hence, a MVP model of the following form (Equation (7)) was used to test the hypothesis:

\[ Y_{1i} = X_{1i} \beta_j + e_{1i} \]

where \( Y_{1i} (j = 1 \ldots, 3) \) represent the three different ICT tools faced by the \( i \)th youth agripreneurs \( (i = 1 \ldots \ 347) \), \( X_{1i} \) is a \( 1 \times k \) vector of observed variables that affect the choice decision of youth agripreneurs, \( \theta_j = \) a \( k \times 1 \) vector of unknown parameters (to be estimated), and \( e_i \) is the unobserved error term. It is assumed that the error terms (across \( j = 1 \ldots m \) alternatives) are multivariate and are normally distributed with mean vector equal to zero. Therefore, the unknown parameters in Equation (6) are estimated using simulated maximum likelihood. The explanatory variables were derived from a review of past studies on the usage of ICT tools (Benard et al., 2019; Muhammad et al., 2019; Kante et al., 2017; Mittal, 2015). The dependent variable is a dummy variable, which takes a value of 1 for the usage of mobile phone, TV, radio and 0 otherwise. Table 1 describes the characteristics of hypothesized dependent and independent variables in the usage of ICT tools.
Table 1. Description and expected sign of hypothesized dependent and independent variables in the usage of ICT tools

| Variables                  | Descriptions                                                                 | Measurement                                                                 | Expected sign |
|----------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|---------------|
| Dependent                  |                                                                              |                                                                              |               |
| UseICT                     | Usage of ICT tools to access agricultural information and financial services | 1 = Use mobile phone, 0 = otherwise; 1 = Use television, 0 = otherwise and 1 = Use radio, 0 = otherwise |               |
| Independent                |                                                                              |                                                                              |               |
| Age (years)                | Age of household head                                                        | Number of years                                                              | ±             |
| Household labor (Number of adults) | Sex of household head                                     | Dummy 1 = male, 0 = female                                                   | ±             |
| Access to extension (Number of contacts) | Education level                         | Number of years                                                              | +             |
| Distance to output market (km) | Number of adult members            | Number of individuals                                                        | ±             |
| Gender (Male = 1)          | Access to extension services                                                 | Number of contacts with extension agents                                     | ±             |
| Education (Postprimary = 1) | Access to electricity                                                        | Dummy 1 = yes, 0 = no                                                        | +             |
| Access to electricity (1 = yes) | Distance to output market                                      | Distance in kilometers                                                      | ±             |
| Trust Buyers (1 = yes)     | Level of trust to milk buyers                                                | Dummy 1 = high, 0 = low                                                      | +             |
| Access to market information (1 = yes) | Access to market information | Dummy 1 = yes, 0 = No                                                        | +             |
| Receive remittances (1 = yes) | Access to remittance                                                        | Dummy 1 = yes, 0 = No                                                        | +             |
| Complementarity            | Complementarity of ICT tools                                                | Likert 1 = SD, 2 = D, 3 = N, 4 = A, 5 = SA                                  | ±             |
| Relevance                  | Relevance of ICT tools                                                       | Likert 1 = SD, 2 = D, 3 = N, 4 = A, 5 = SA                                  | ±             |
| Feedback                   | Feedback of ICT tools                                                        | Likert 1 = SD, 2 = D, 3 = N, 4 = A, 5 = SA                                  | ±             |
| Timeliness                 | Timeliness of ICT tools                                                      | Likert 1 = SD, 2 = D, 3 = N, 4 = A, 5 = SA                                  | ±             |
| Accessibility              | Accessibility of ICT tools                                                   | Likert 1 = SD, 2 = D, 3 = N, 4 = A, 5 = SA                                  | ±             |
| Portability                | Portability of ICT tools                                                     | Likert 1 = SD, 2 = D, 3 = N, 4 = A, 5 = SA                                  | ±             |

SD, strongly disagree; D, disagree; N, neutral; A, agree; SA, strongly agree.

4. Results and discussion

4.1. Socioeconomic and institutional characteristics of respondents

Table 2 shows the socioeconomic and institutional attributes of dairy youth agripreneurs in Tanzania. The variables access to extension, gender, access to electricity, trust buyer, access to market information and receive remittances were statistically significant at 1% between the users of mobile phone, TV and radio. The results show that the mean age of the respondents was 33 years, suggesting that dairy farming is mostly done by youths who are almost moving from that age bracket. This is probably because dairy farming requires substantial investment in cows, land, inputs such as feeds, and animal health services, which need financial support. The majority of
Table 2. Socioeconomic and institutional characteristics of respondents

| Variables                        | Mobile phone | Television | Radio | Pooled |
|----------------------------------|--------------|------------|-------|--------|
|                                  | Mean         | SD         | Mean  | SD     |
| Age (years)                      | 33.1         | 2.39       | 32.9  | 2.59   |
| Gender (Male = 1)                | 0.8          | 0.39       | 0.8   | 0.42   |
| Household labor (Number of adults)| 3.0          | 1.45       | 3.0   | 1.15   |
| Education (Postprimary = 1)      | 0.2          | 0.37       | 0.3   | 0.44   |
| Access to extension (Number of contacts) | 3.9          | 2.25       | 3.7   | 2.29   |
| Distance to output market (km)   | 0.7          | 0.79       | 0.6   | 0.66   |
| Access to electricity (1 = yes)  | 0.8          | 0.42       | 0.9   | 0.18   |
| Trust buyers (1 = yes)           | 0.9          | 0.28       | 0.9   | 0.29   |
| Access to market information (1 = yes) | 0.6          | 0.48       | 0.5   | 0.50   |
| Access to receive remittances (1 = yes) | 0.3          | 0.46       | 0.3   | 0.46   |

|                                  | Mean         | SD     | Mean  | SD     | Mean  | SD   | F-value |
|----------------------------------|--------------|--------|-------|--------|-------|------|---------|
|                                  |              |        |       |        |       |      |         |
|                                  |              |        |       |        |       |      |         |
|                                  |              |        |       |        |       |      |         |
|                                  |              |        |       |        |       |      |         |
| Age (years)                      | 33.1         | 2.39   | 32.9  | 2.59   | 33.1  | 2.17 | 32.8    | 2.86   | 1.11 |
| Gender (Male = 1)                | 0.8          | 0.39   | 0.8   | 0.42   | 0.8   | 0.39 | 0.7     | 0.44   | 3.31*** |
| Household labor (Number of adults)| 3.0          | 1.45   | 3.0   | 1.15   | 2.9   | 1.40 | 2.9     | 1.40   | 1.06 |
| Education (Postprimary = 1)      | 0.2          | 0.37   | 0.3   | 0.44   | 0.2   | 0.38 | 0.2     | 0.38   | 1.40 |
| Access to extension (Number of contacts) | 3.9          | 2.25   | 3.7   | 2.29   | 3.6   | 2.79 | 3.4     | 2.39   | 2.59*** |
| Distance to output market (km)   | 0.7          | 0.79   | 0.6   | 0.66   | 0.6   | 0.69 | 0.6     | 0.72   | 0.75 |
| Access to electricity (1 = yes)  | 0.8          | 0.42   | 0.9   | 0.18   | 0.7   | 0.45 | 0.7     | 0.46   | 6.97*** |
| Trust buyers (1 = yes)           | 0.9          | 0.28   | 0.9   | 0.29   | 0.9   | 0.34 | 0.8     | 0.40   | 6.98*** |
| Access to market information (1 = yes) | 0.6          | 0.48   | 0.5   | 0.50   | 0.5   | 0.50 | 0.4     | 0.49   | 16.92*** |
| Access to receive remittances (1 = yes) | 0.3          | 0.46   | 0.3   | 0.46   | 0.2   | 0.42 | 0.2     | 0.40   | 4.66*** |

***Statistically significant at 1% probability level.
youths lack the financial capability to engage in dairy farming. Access to credit as a limiting factor for the engagement of youth in agribusiness (FAO, 2014).

In relation to household head sex, 70% of the sampled households were male-headed while female accounted 30%. Sex has implication on the roles and responsibilities in the society, and therefore can influence households’ abilities to generate income. Male-headed households have higher access to productive resources and information that increases the chances of utilizing ICT in farming (Machina & Lubungu, 2018). The mean number of adults in the household, which was used as a proxy for household labour endowment, was three persons. This result is below the national Tanzania household size of 4.8 people per household which implies that the average household size in Tanzania is reducing.

Majority (80%) of dairy youth agripreneurs had attained primary education, with only 20% of the respondents having postsecondary education. These results indicate low levels of literacy among the respondents, even though access to education could increase the working efficiency resulting in more income and food security. In addition, education is important to manage the business as well as in the utilization of ICT. Education is one of the long-term strategies that could be used to improve dairy cow and milk production and marketing (Ishaq et al., 2017). Ngeno (2018) found similar findings concerning education level, whereby the majority of dairy farmers in Kenya had reached the primary education level.

The number of extension contacts was used as a proxy for information access, and on average, the households had four contacts annually with extension agents. Extension services provide farmers with agricultural information they need in the usage of technologies. They are also crucial in the dissemination of new technologies and consequently affect their household welfare (Mwaura et al., 2014). Distance to the nearest output market was used as a proxy for market access, and the findings indicate that mobile users had the highest mean distance to the output market of 0.7 km compared to 0.6 km of radio users. This indicates why the mobile users preferred using the ICT tool to bridge the distance gap to the market, whereby they could use the tool to communicate with the buyers and extension agents. This result is consistent with the findings of Sekobira et al. (2012), who found market distance constrains trigger households to adopt ICT tools such as mobile phones to access agricultural markets.

Majority of the respondents (70%) had access to electricity, with users of TV having the highest (90%) access. This implies that majority of youth agripreneurs could freely use any ICT tool given that electricity was available. Muhammad et al. (2019) argued that ICT tools are electricity-dependent; therefore, for effective use of these tools, households should have access to electricity. They also found that electricity shortage and availability in connections, especially in rural areas, were perceived leading obstacles that hindered smallholder farmers from accessing agricultural information using ICT tools. Concerning respondents’ level of trust to buyers, 80% of the respondents trusted their buyers of milk. This implies that physical meeting with buyers was not a must hence they could use ICT tool such as mobile to market their produce. In relation to access to market information and remittance, only 40% and 20% of the respondents respectively had access to these services using ICT tools. These findings depict the low utilization of smallholder farmers to access market information and financial services using ICT tools such as mobile phones, which has taken a precedence role in dissemination of these services (Mwantimwa, 2019).

4.2. Dairy youth agripreneurs’ perception of the attributes of ICT tools
Figure 1 presents the scores of the smallholder dairy youth agripreneurs’ perceptions of ICT tools’ attributes that were measured on a 5-point Likert scale, with 1 being strongly disagree, and 5 being strongly agree. Regarding the complementarity of ICT tools, mobile phone had the highest score (3.97). This means that it could easily be combined with other ICT tools to access agricultural information. In terms of the relevance of information, mobile phones had the highest score (3.88) followed by TV (3.52). This meant that the smallholder farmers preferred using these tools because
of their abilities to disseminate relevant agricultural programs that are tailored to the needs of the farmers (Mtega & Msungu, 2013).

The ability of the ICT tools to give quick feedback to the smallholder farmers is an important attribute. Among the three ICT tools considered, mobile phones had the highest score (3.84), whereas TV scored the least (2.66). The findings show mobile phones could offer youth dairy agripreneurs and other value chain actors one-to-one communication and quick feedback in relation to agricultural transactions. Moreover, the mobile phone had the highest score regarding timeliness, accessibility and portability attributes, which were 3.82, 3.96 and 4.10, respectively. Overall, the mobile phone scored highly with regard to the six attributes of the ICT tools. The finding concurs with Muhammad et al. (2019) and Benard et al. (2019), who found mobile phones were highly accessed and most frequently used by rural smallholder farmers. This could be due to its portability, compatibility, ease and convenience in getting agricultural information, money transfer and communication.

4.3. Role of ICT attributes on the choice of ICT tools among youth dairy farmers

MVP model was used to model the role of socioeconomic, institutional and ICT attributes on the choice of ICT tools, and Table 3 presents correlation coefficients between the error terms of the three equations of ICT tools’ usage. All three pairs of the estimated correlation coefficients were statistically significant, suggesting a strong interdependence among the three ICT tools in usage to access agricultural information and other uses such as access to financial services.

Table 4 presents the results of the MVP model estimated using maximum likelihood method. Our estimates show that the model fits the data well as the Wald test \( \chi^2 (48) = 202.71, p = 0.001 \) and the likelihood ratio test \( \chi^2 (3) = 21.38, p = 0.001 \) reject the null hypothesis that all regression

| Table 3. Correlation coefficients for MVP regression equations |
|---------------------------------------------------------------|
| **Use of ICT tools** | **Mobile phones** | **Television** | **Radio** |
|-----------------------|------------------|---------------|----------|
| Mobile phones         | 1.0000           |               |          |
| Television            | 0.3230***        | 1.0000        |          |
| Radio                 | 0.1695***        | 0.1536***     | 1.0000   |

***Indicate statistical significance at 1% significance level.
Table 4. Parameter estimates from multivariate probit and individual probit models for estimating determinants of ICT tools’ use among youthful dairy agripreneurs

| Variables                          | Multivariate probit estimates | Individual probit estimates |
|------------------------------------|-------------------------------|-----------------------------|
|                                    | MP                            | TV                          | RD                           | MP                            | TV                          | RD                           |
| Age (years)                        | 0.0018                        | 0.0080                      | 0.0719                       | -0.0021                       | 0.0384                      | 0.0794**                     |
|                                    | (0.0359)                      | (0.0432)                    | (0.0501)                     | (0.0360)                      | (0.0382)                    | (0.0392)                     |
| Gender (Male = 1)                  | 0.2454                        | -0.0254                     | 0.0645                       | 0.2498                        | 0.0536                      | 0.3181                       |
|                                    | (0.2343)                      | (0.2913)                    | (0.2457)                     | (0.2382)                      | (0.2433)                    | (0.2079)                     |
| Education                          | -0.1063                       | -0.0670                     | -0.3414                      | 0.0555                        | 0.3967                      | -0.4059                     |
| (Postprimary = 1)                  | (0.2845)                      | (0.3632)                    | (0.2958)                     | (0.2906)                      | (0.2563)                    | (0.2519)                     |
| Household labor (Number of adults) | 0.0530                        | -0.0618                     | -0.0063                      | 0.0165                        | -0.0301                     | -0.0310                      |
|                                    | (0.0722)                      | (0.1011)                    | (0.0821)                     | (0.0715)                      | (0.0722)                    | (0.0674)                     |
| Access to extension (Number of contacts) | 0.1800***                    | 0.0488                      | 0.0361                       | 0.0992***                     | -0.0082                     | 0.0173                       |
|                                    | (0.0394)                      | (0.0557)                    | (0.0474)                     | (0.0403)                      | (0.0424)                    | (0.0377)                     |
| Access to electricity (1 -yes)     | 0.5177**                      | 1.6563***                   | 0.0172                       | 0.4001**                      | 1.2914***                   | 0.1196                       |
|                                    | (0.2498)                      | (0.6023)                    | (0.2376)                     | (0.2527)                      | (0.5315)                    | (0.1083)                     |
| Distance to output market (km)     | -0.0236                       | -0.3320                     | -0.1617                      | -0.0223                       | -0.1898                     | -0.3158                      |
|                                    | (0.1269)                      | (0.2122)                    | (0.1376)                     | (0.1219)                      | (0.1358)                    | (0.1183)                     |
| Trust buyers (1 -yes)              | 0.5515*                       | 1.5099***                   | 0.3200                       | 0.6282**                      | 1.0922***                   | 0.5413*                      |
|                                    | (0.3064)                      | (0.4799)                    | (0.3628)                     | (0.2109)                      | (0.3956)                    | (0.2883)                     |
| Access to market information (1 -yes) | 0.0842**                    | 0.8046***                   | 0.3420                       | 1.0152**                      | 0.2633                      | 0.4664**                     |
|                                    | (0.2529)                      | (0.3240)                    | (0.2805)                     | (0.2317)                      | (0.2121)                    | (0.2121)                     |
| Receive remittances (1 -yes)       | 0.6400**                      | 0.0195                      | -0.0209**                    | 0.5796**                      | 0.0751                      | -0.1678                      |
|                                    | (0.3033)                      | (0.3257)                    | (0.3131)                     | (0.3015)                      | (0.2518)                    | (0.2312)                     |
| ICT-related attributes             |                               |                             |                              |                              |                             |                              |
| Complementarity                    | 0.0950                        | 1.3275***                   | 0.5376**                     | 0.2070                        | 0.4567**                    | 0.2702                       |
|                                    | (0.2447)                      | (0.3370)                    | (0.2373)                     | (0.2443)                      | (0.2505)                    | (0.2193)                     |
| Relevance                          | 0.5268**                      | 0.0273                      | 0.5402**                     | 0.5385**                      | -0.1419                     | 0.0891                       |
|                                    | (0.2471)                      | (0.2712)                    | (0.2240)                     | (0.2549)                      | (0.2637)                    | (0.2143)                     |
| Feedback                           | 0.2435                        | 0.1276                      | -0.3473**                    | 0.0734                        | -0.2459                     | 0.2519                       |
|                                    | (0.2558)                      | (0.2300)                    | (0.1785)                     | (0.2567)                      | (0.2334)                    | (0.2026)                     |
| Timeliness                         | -0.2473                       | 0.7847***                   | 0.4729**                     | -0.1707                       | -0.0548                     | -0.0752                      |
|                                    | (0.2302)                      | (0.2338)                    | (0.1790)                     | (0.2323)                      | (0.2418)                    | (0.2093)                     |
| Accessibility                      | -0.1043                       | 0.4850**                   | 0.4195**                     | -0.1597                       | 0.0749                      | -0.2479                      |
|                                    | (0.2511)                      | (0.1822)                    | (0.1936)                     | (0.2647)                      | (0.2676)                    | (0.2138)                     |
| Portability                        | 0.2530                        | 0.1080                      | 0.1967                       | 0.3936                        | 0.2154                      | 0.0531                       |
|                                    | (0.2305)                      | (0.1503)                    | (0.2266)                     | (0.2402)                      | (0.2366)                    | (0.2039)                     |
| Constant                           | -0.8548**                     | -12.8458***                 | -9.2511**                    | -9.2297***                    | -5.2477***                  | -4.8230**                    |
|                                    | (1.6381)                      | (2.0819)                    | (1.9015)                     | (1.4910)                      | (1.5231)                    | (1.4791)                     |

Notes: LR Test for indep. Eqns. Rho21 = rho31 = rho32 = 0. Ch2(8) = 199.69; Prob > ch2 = 0.0000. Wald ch2(48) = 199.69; Prob > ch2 = 0.0000. *, ** and ***Significant at 10%, 5% and 1% level, respectively (figures in parentheses are robust standard errors). MP, mobile phone; TV, television; RD, radio.

coefficients in each equation are jointly equal to zero. This indicates that multiple uses of different ICT tools among households are not mutually independent and MVP specification fits the data.

4.3.1. Socioeconomic and institutional factors influencing usage of ICT tools

More extension contacts are likely to influence the use of mobile phones at 1% significance level (Table 4). This indicates that access to extension services would increase the utilization of mobile phones in accessing technical, market and financial services. Extension services would enhance youth agripreneurs’ ability to use mobile phones through ICT capacity building (Benard et al., 2019). This result is in line with those from Mtega and Msungu (2013), who highlight the role of extension agents on enhancing the utilization of mobile phones as sources of agricultural information.
Access to electricity affects the use of ICT tools, with households having electricity more likely to use mobile phones and TV at 5% and 1% significance levels, respectively. Electricity enhances power availability which stimulates the use of mobile phones and TV not only because of the practicability of use due to the presence of electrical power but also because mobile phones and TVs provide audiovisual agricultural information with phones having the added advantage of internet availability and facilitating communication hence providing a more convenient and easy to access technical, market and financial information. This result is similar with Msoffe and Ngulube (2016) who found that farmers with electricity in their households tend to use ICT tools such as mobile phones and TV due to availability of power to operate the tools.

Higher levels of trust for buyers significantly enhance the use of mobile phones and TVs at 5% and 1% significance levels, respectively. The plausible explanation could be more buyer trust reflects higher likelihood of a reliable market channel. Therefore, youths who trust their buyers are more likely to use mobile phones in business transactions and TV as their preferred sources of information. This finding is similar with Muhammad et al. (2019) who found availability of trusted buyers encourages farmers to mobile phones and TV as a source of agricultural and market information.

Access to market information significantly influenced the use of mobile phones and TVs at 1% significance level. Having market information enables farmers to position themselves in a manner that helps them combat negative anticipated market trends such as an increase in input prices and facilitates them to capitalize on favorable market trends such as an increase in output prices. These findings are consistent with Benard et al. (2019) who reported that farmers with market information prefer the use of mobile phones and TVs because mobile phones and TVs provide audiovisual agricultural information with phones having the added advantage of facilitating communication, hence providing a more convenient and easy way to understand sources of information.

Households receiving remittances are more likely to use mobile phones but less likely to use radio at a 5% and 1% significant levels, respectively. Radios provide a cheap source of information, although their mode of transmission is only limited to audio format. On the other hand, mobile phones not only provide information in audio, visual and text formats but also facilitates one-on-one communication. Therefore, through receiving remittance, youth agripreneurs are prompted to switch from the use of radio to the use of mobile phones whose content and features are more convenient and easy to understand. This result is consistent with Msoffe and Ngulube (2016) who reported that remittance from social networks enhances ICT use in rural agrienterprises.

4.3.2. Role of ICT tools’ attributes on usage
Complementarity affects the use of radio and TVs at 5% and 1% significance levels, respectively. The plausible explanation could be due to the fact that most TV and radio stations are owned by similar media houses and therefore have similar programs on both radio and TV. Furthermore, these media houses usually have similar news headlines, and therefore farmers can switch between the two tools without fear of missing some important agricultural news. This is consistent with Macire Kante (2016) who reported that complementarity as a perceived ICT tools’ attribute would enhance farmers' attitude to access agricultural information using TV and radio.

Ability of the ICT tool to give more relevant information increases the likelihood of using mobile phone and radio at 1% significance level. Mobile phones are considered a relevant source of information because they have both audiovisual and text content hence usable by youth agripreneurs with different education levels, and the audiovisual content not only tells them what to do but also shows them how best to do it. Furthermore, a youth agripreneur can request for specific information needed and get it either through the internet or SMS. It has a communication function hence enabling a farmer to correspond with specialists. By facilitating communication with extension agents, mobile phones enable farmers to access correct and trustable information (Benard et al., 2019). On the other hand, most radio stations are able to disseminate information in local languages, which makes them very relevant to the farmers. This result is in line with those from
Kante et al. (2018) who found higher preference for radio and mobile phones due to their ability to give relevant and efficient agricultural information and financial services among rural farmers.

The prioritization of feedback as the desired attribute reduced the likelihood of using radio as the preferred ICT tool at 5% significance level. Radio stations only reserve a few minutes during their programs for listener calls. Because of the large number of listeners and limited time, only a few lucky listeners can air their opinions. Therefore, youth agripreneurs who prefer feedback on their opinions refrain from depending on the radio. This is inconsistent with results by Mtega and Msungu (2013) who reported that farmers were more likely to use radio to access agricultural information due to ability to receive feedback after asking questions or clarifications. These encourage farmers to seek further clarifications from radio stations broadcasting agricultural programs.

Youth agripreneurs who demand timely delivery of information by ICT tools prefer TV and radio at 1% significance level. These two ICT tools feature stories based on current events and trends. Youth agripreneurs are therefore more likely to receive information on expected weather patterns, government policies and expected market prices more timely on radio and TV. The timeliness aspect of ICT tools especially in radio and TV is essential as youth training on relevant, timely agricultural innovations and methods of utilizing technologies is very crucial towards imparting knowledge on agricultural entrepreneurship and encouraging youth to venture into farming for commercial purposes either on a small-scale or large-scale level. This result is similar to those from Kante et al. (2017), who find that timeliness as a perceived ICT tools’ attribute tends to increase the probability of adopting the ICT-based farm input information.

Accessibility of the ICT tools is more likely to influence the use of radio and TV at 5% and 1% significance levels, respectively. This is because there exist regional radio and TV stations that broadcast in vernacular languages; hence, all farmers, both educated and non-educated, can understand the information. Furthermore, these stations are broadcasted free of charge, hence affordable to all. For many African farmers, the only source of information outside the community is the radio. Mtega and Msungu (2013) reported that radio sets are relatively inexpensive and can be used in remote areas where electricity supplies are unreliable or even non-existent. Benard et al. (2019) found similar results that accessibility of local radio stations offers farmers a relatively low-cost access to agricultural information.

5. Conclusion
The objective of this study was to determine the effect of ICT tools’ attributes in accessing technical, market and financial information among youth dairy agripreneurs in Tanzania. In achieving the objective, a MVP regression model was used, and the results indicate that the majority of youths were using mobile phones, followed by radio and TV. Farmers’ characteristics, including extension contacts, installation of electricity, level of buyer trust, availability of market information and receiving of remittances, are found to be the key factors affecting the use of ICT tools. The results of this study further highlight the crucial role of ICT attributes that are relevant to improving the utilization of ICT tools among youth dairy agripreneurs. The key attribute that positively influenced the use of mobile phones was relevance while complementarity, timeliness and accessibility positively influenced the use of TV. Finally, complementarity, relevance, timeliness and accessibility positively influenced the use of radio, while feedback attribute had a negative influence. This raises policy concerns on the significance of ICT attributes in the dissemination of agricultural information which has important implications for interventions aiming to progress dairy youth agripreneurs participation in agribusiness through ICT use.

6. Policy implications
Results from the present study provide evidence for service providers of ICT-based programs to take consideration of specific ICT tools’ attributes (complementarity, accessibility, relevance, feedback and timeliness), which are important in the adoption and use of ICT among youthful dairy agripreneurs. They also need to consider the identified socioeconomic and institutional characteristics that influence the
choice of ICT tools. It is therefore essential that policymakers, extension officers, dairy agripreneurs and ICT providers collaborate to ensure that all agricultural information available on ICT tools displays complementarity, relevance, accessibility and feedback to an acceptable degree; and can easily be used by less educated youth dairy agripreneurs. This may be achieved by setting up an oversight task force that ensures the relevance and suitability of all agricultural information disseminated via all ICT tools to the needs of the subscribers. Public and private extension agents are required to create awareness on the use of ICT among the farming communities, by identifying young farmers who have a higher probability to use ICT tools and ensuring they have access to reliable sources of electricity, extension contacts and market information which could facilitate increased usage of ICT tools in agribusinesses. Finally, due to the limited number of extension staff in the country, the government in partnership with the private sector should develop ICT-based services to increase the accessibility of extension services to smallholder youth dairy agripreneurs.

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Competing interests
The authors declare no competing interests.

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Notes
1. Refers to the ability of an ICT tool to be combined with other ICT tools to access agricultural information.
2. Refers to the extent to which an ICT tool is convenient to agro-entrepreneurs to obtain agricultural information and undertake agricultural transactions.
3. Refers to the ability of an ICT tool to convey information that will bring value in agro-enterprises.
4. Refers to the ability of an ICT tool to provide agro-entrepreneurs with the information at the right time so as to improve the performance of their agro-enterprises.
5. Refers to the ability of an ICT tool to give quick response when used.
6. Refers to the ability to move easily from place to another using an ICT tool.

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