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Access to veterinary services and expenditure on pig health management: the case of smallholder pig farmers in Northern Uganda

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Abstract
Pig farming has gained momentum for most smallholder farmers in developing countries as a means of livelihood and household incomes. However, prospects of the pig enterprises are constrained by pig health management issues which affect both its productivity and profitability. Using a cross-sectional survey of 240 smallholder pig farmers, we assessed factors influencing farmers' access to veterinary services and expenditure on pig health management in northern Uganda. Data was analysed using the binary logit and censored tobit regression models. Access to veterinary services was significantly influenced by pig herd size ($p < 0.05$), Village Savings and Loan Association (VSLA) membership ($p < 0.1$), breed ($p < 0.05$), production system ($p < 0.05$) and number of health issues recorded on farm ($p < 0.01$). Education level ($p < 0.01$), farming household members ($p < 0.05$), pig herd size ($p < 0.01$), breed ($p < 0.05$), previous disease incidences ($p < 0.05$), household labour available ($p < 0.1$) and access to veterinary services ($p < 0.01$) significantly influenced pig health expenditure. Efforts to improve access to veterinary services and improve pig health management should focus on promoting more intensive production systems and improved breeds that are associated with better access to veterinary services and reduced cost of pig health management.

Keywords Smallholder · Pig production · Pig health · Expenditure · Veterinary service · Uganda

Introduction

Sub-Saharan Africa (SSA) has realized a rapid increase in pig production and consumption of pork (OECD and FAO 2016). The SSA pig population increased from 21.5 million in 2000 to 40.5 million in 2018. In 2016, the share of the gross domestic product (GDP) from piggery to total livestock GDP was over 3.7% (FAO 2020). According to the Uganda Bureau of Statistics (UBOS), there are over 4.2 million pigs in Uganda (UBOS 2019), an increase of over 2.6 million pigs since 2000 (FAO 2020). The sub-sector contributes over 12% of the total livestock GDP and over 3.4% of the total agricultural GDP in the country (UBOS 2019; FAO 2020). Within the country, northern Uganda has the least pig population, with only 13% of the total pig population in the country (UBOS 2019), owned by about 10% of the households (Tatwangire 2014). Within northern Uganda, there are also significant variations across districts. For instance, the three districts of Gulu, Omoro and Kitgum have 16% of the pigs in northern Uganda (UBOS 2019) and 13% of all pig rearing households (Tatwangire 2014) in the region. Despite the low pig numbers in the region, the piggery enterprise has become an important source of food security, income and employment for an increasing number of smallholder farmers (Tatwangire 2014; Ndyomugyenyi and Kyasimire 2015; Chenais et al. 2017). The increasing interest in pig production has been attributed to the special characteristics of pigs such as the short gestation periods and rapid multiplication rates (Madzimure et al. 2012; Tatwangire 2014; Munzhelele et al. 2016).

Prospects of the pig sub-sector are, however, constrained by pig health management issues which affects its productivity and profitability (Madzimure et al. 2012; Muhanguzi et al. 2012; Tatwangire 2014; Ndyomugyenyi and Kyasimire 2015). For instance, there are persistent outbreaks of African

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Swine Fever (ASF), which is endemic to Uganda (Atuhaire et al. 2013; Chenais et al. 2015; Chenais et al. 2019). Other pig health issues common in the region include foot and mouth disease, piglet anaemia, *helminthosis*, scabies, mange, lice, flies, cough, diarrhoea and malnutrition which collectively account for over 31% morbidity and 23% mortality (Tatwangire 2014; Dione et al. 2014; Dione et al. 2018; Kungu et al. 2019).

In the face of parasites and disease outbreaks, their control and management become very critical to the success of the pig business. Where it is properly done, the control of livestock parasites and diseases significantly improves smallholder incomes (Perry and Rich 2007; Perry and Grace 2009). Despite efforts to control pig parasites and diseases, there is still a high burden of pig parasites and diseases in the region (Tatwangire 2014; Ouma et al. 2018; Chenais et al. 2019; Kungu et al. 2019). Farmers' efforts to control pig parasites and diseases are hampered by the poor access to veterinary services and the high cost associated with parasites and disease management (Tatwangire 2014; Dione et al. 2014; Ilukor 2017; Dione et al. 2020). This is in part due to the poor understanding of the factors associated with pig health management. Management practices available to farmers include consultations with veterinary profesionals and paraprofessionals, deworming, administration of antibiotics and practices biosecurity measures.

An understanding of why the challenge of assessing and/or paying for pig health management has persisted amidst the presence of practical options is important in addressing the challenge. For pig production to contribute significantly to incomes of smallholder farmers, access to veterinary services and expenditure on pig health are important since they greatly influence final profits (Perry and Grace 2009). Incidences of parasites and diseases have the potential of causing significant economic losses, either through high mortality rates such as in the case of ASF outbreaks (Penrith 2020) or increased cost of managing the outbreak and investments in disease prevention such as biosecurity measures, which subsequently reduces the expected profits (Ouma et al. 2018). Pig health management thus become very important in improving pig production incomes. According to K'Oloo et al. (2015), the high cost of accessing veterinary services discourages farmers from using private animal health assistants (PAHA) for non-trained service providers, even though the farmers had high preferences for the PAHA. Understanding factors associated with access to veterinary services and expenditure on pig health management thus becomes very critical in improving farmers' access to veterinary services and overall pig health expenditure and management. This study assessed the socioeconomic and farm related determinants of pig health management with specific focus on factors associated with access to veterinary services and expenditure on pig health management in northern Uganda.

By identifying factors that negatively/positively influence farmer's access to veterinary services and expenditure on pig health management, it is possible to use these factors for designing strategies for improving access to veterinary services and expenditure on pig health management. Understanding these factors is, therefore, crucial in influencing strategies that improve overall pig health management for better outcomes in terms of improved productivity and profitability, if they are used to influence policy. In pig production, veterinary services in particular and pig health management in general are crucial in that they do not only improve the farm productivity and incomes but also increase consumer confidence in the consumption of livestock products in terms of increased food safety (Bellemain 2013). With the need to improve pig health management for smallholder farmers, this study provides evidences for decision-making when developing and promoting pig health management strategies.

Methodology

Study area

This study was carried out in the northern Ugandan districts of Gulu, Kitgum and Omoro. The districts are located on geographical coordinates 02° 49′ 50″ North, 32° 19′ 13″ East, for Gulu; 02° 35′ North 32° 22′ East, for Omoro; and 3° 17′ 20″ North, 32° 52′ 40″ East, for Kitgum. Gulu district, which is located on an elevation of 1100 m above sea level, has an annual average rainfall of 1507 mm and average daily temperature of 23.0 °C. Omoro district, located on an elevation of 1037 m above sea level, has an annual average rainfall of 1165 mm and average daily temperature of 23.8 °C. Kitgum district with an elevation of 760 m above sea level has an annual average rainfall of 911 mm and average daily temperature of 24.0 °C. The main economic activity in these three districts is farming which is practiced mainly on small scale by over 80% of the households (UBOS 2016). The main crops produced include maize, cassava, rice, beans, millet, sorghum, sweet potatoes, sesame and groundnuts, while the main livestock reared include cattle, goats, chicken and pigs. Livestock are reared throughout the year, while crops are cultivated in two planting seasons that follow the rainfall pattern.

Sampling design

Using structured questionnaires, cross-sectional primary data was collected from a sample of 240 smallholder pig farmers. Sampling followed a multi-stage approach where the study district was purposively selected based on the prevalence of disease outbreaks and pig population. Thereafter, eight sub-counties were purposively selected to be included in the study. Four of the sub-counties were from the rural locality, while the other four were from the urban locality. From the eight sub-counties, a total of 16 villages were purposively selected basing on the recommendations of the district production officers on villages with high concentration of pig farmers. A total of 16 pig farmers were then selected and interviewed, giving a total of 256. However, after data collection, information for 16 respondents was dropped due to incompleteness of responses, thereby reducing the effective sample size to 240, which were used for subsequent analysis.

Data collection

Data was collected using interviewer-administered questionnaire. The questionnaire was pretested and appropriate adjustments made before producing the final version. Data collection took place from March to April 2018. Data was collected on socioeconomic variables, pig production related variables including pig health management, and factors that can influence pig health management on the farm. Data were also collected on incidences of health issues recorded on the pig farm and common health issues in the locality. Data was also sought on expenditure on pig health management.

Data analyses

Collected data were analysed using STATA (v14) statistical package. After entry, the data were cleaned for potential outliers before subjecting them to rigorous statistical analyses. The data cleaning process started with preliminary descriptive analysis for purposes of identifying irregularities and inconsistencies in dataset, which were corrected by crosschecking on the hard copy questionnaires of data collected. Outliers were identified by plotting scatterplots for variables with potential outliers. Identified outliers were examined and dealt with by cross-checking on the hard copy questionnaires for potential errors during data entry and correcting it appropriately. Normality tests were also conducted using Shapiro-Wilk test for normality that informed on the choice of the appropriate regression model. Descriptive analysis was performed on the characteristics of the study population.

Estimating determinants of access to veterinary services

Access to veterinary services was operationalized as whether or not a farmer has used any veterinary services in the last 1 year of pig production. Thus, access to veterinary services was measured as a dummy variable with 1 denoting access and 0 otherwise. Given the binary nature of the outcome variable, the study adopted the binary regression model for analysing the factors that influence access to veterinary services. Two models are available for estimation of binary dependent variables: the logistic regression model which assumes logistic distribution of the error term and the probit regression model which assumes a normal distribution of the error term (Cameron and Trivedi 2005; Wooldridge 2016). In this study, the logit model was estimated by assuming the logistic distribution of the error term. The logit model is specified as follows:

Let z be the binary outcome variable access to veterinary services. z is defined as follows:

$$z_i = \begin{cases} 1 \text{ if the } i^{\text{th}} \text{ farmers uses veterinary services} \\ 0 \text{ otherwise} \end{cases} \quad (1)$$

In this case, z_i is a latent variable that with probabilities, p for $z_i^* = 1$ and $1-p$ for $z_i^* = 0$. The binary dependent variable is regressed against x variables as specified in Eq. (2).

$$z_i^* = x_i'\delta + u_i \quad (2)$$

where x_i represents a vector of explanatory variables which influence access to veterinary services such as marital status, number of pigs, breeds, Village Savings and Loan Association (VSLA) membership, breeds on farm, production system and number health issues recorded on farm, farm location (urban or rural), farmers experience, education level and access to extension services. Table 1 presents a detailed description of explanatory variables used and their hypothesized effect on the dependent variable. δ is a vector of parameters (coefficients) associated with the explanatory variables to be estimated. The conditional probability of the logit model was estimated from specification in Eq. (3).

$$\Pr(z_i = 1|x) = F\left(x_i'\delta\right) \quad (3)$$

where $F(.)$ is the cumulative logistic density function that applies to the binary logit model. The marginal effects with respect to changes in the explanatory variable on the probability of accessing veterinary services were estimated from the specification in Eq. (4).

$$\frac{\partial \Pr\left[z_i = 1|x_{ij}\right]}{\partial x_{ij}} = \frac{\exp\left(x'\delta\right)}{1+\exp(x'\delta)} \quad (4)$$

The parameters of the binary logistic model were estimated using the method of maximum likelihood estimation (MLE).

Factors influencing expenditure on pig health management

In investigating the factors influencing pig health expenditure, a multivariate regression of the average monthly pig health expenses on a set of independent variables was used. Given that not all farmers spent on health management, the dependent variable, expenditure on health management, had zero as a response for such farmers,

Table 1 Description of explanatory variables for the logit and tobit regression models

Variable	Description	Hypothesized effect	
		Logit	Tobit
Location	Dummy for urban (urban = 1, rural = 0)	+	+
Gulu	Dummy = 1 if farmers is in Gulu district	NA	±
Kitgum	Dummy = 1 if farmers is in Kitgum district	NA	±
Omoro	Dummy = 1 if farmers is in Omoro district	NA	±
Married	Dummy = 1 if farmer is married, 0 = otherwise	±	±
Experience	Total years of experience in pig production	−	−
Education	Total years of formal schooling	+	+
Household size	Number of household members involved in farming	NA	±
Herd size	Number of pigs on farm	+	+
Other livestock species available	Number of other livestock species reared by farmer (includes: cattle, goats, sheep, chicken and ducks)	+	+
Extension	Dummy =1 if farmer has received pig related extension services	+	+
Access to credit	Dummy =1 if farmers has access to credit	NA	+
VSLA Membership	Dummy = 1 if farmer is a member of VSLA	+	+
Local breed	Dummy = 1 if farmer is keeps local breeds on farm	−	±
Crosses	Dummy = 1 if farmer is keeps cross breeds on farm	±	−
Exotic breed	Dummy = 1 if farmer is keeps exotic breeds on farm	+	−
Farming experience	Total number of years farmers has been involved in farming	NA	−
Semi intensive	Dummy = 1 if productive system is semi-intensive	±	−
Extensive	Dummy = 1 if productive system is extensive	−	−
Intensive	Dummy = 1 if productive system is intensive	+	+
ASF	Dummy = 1 if ASF has ever been reported in farm	NA	−
Worms	Dummy = 1 if worms has ever been reported in farm	NA	+
Mange	Dummy = 1 if mange has ever been reported in farm	NA	+
Anaemia	Dummy = 1 if piglet anaemia has ever been reported on farm	NA	+
Lice	Dummy = 1 if Lice has ever been reported in farm	NA	+
Full-time labour	Full-time labour for pig production—number	NA	−
Health issues on farm	Number of health issues ever recorded on farm	+	+
Common health issues	Number of health issues common in farmers locality	+	+
Veterinary Service	Dummy = 1 if farmer uses veterinary services, 0 if otherwise	NA	−

NA not applicable

hence zero censored. According to Wooldridge (2016), consistent estimates of such zero-centred dependent variables are obtained by the method of maximum likelihood estimation (MLE) of the tobit regression model. The tobit model uses MLE procedures to estimate errors in the presence of non-normal distribution (Cameron and Trivedi 2005). According to Wooldridge (2016), MLE is considered the most efficient estimator for asymptotically distributed dependent variable. The tobit model has been used for several studies (Yoo 2005; Yue and Hong 2012; Okello et al. 2019; Amore and Murtinu 2019).

Following Wooldridge (2016), the tobit regression model was specified as in Eq. (5):

$$Y^* = X_i\beta + u_i \tag{5}$$

where Y^* is the dependent latent variable that takes on values with both lower and upper bounds, X_i is a vector of independent variables, β is a vector of parameters to be estimated, while u_i is an error term which is assumed to be independent and identically distributed.

The analytical model specified in Eq. (5) was modified for analysis of factors influencing pig health expenditure of pig smallholder pig farmers in northern Uganda as in Eq. (6):

$$\text{Health\_exp}_i^* = X_i\beta + u_i, \tag{6}$$

where

$$\text{Healthexp}_i = 0 \text{ if } \text{Healthexp}_i^* < 0$$

$$\text{Health\_exp}_{ij} = \text{Health\_exp}_i^* \text{ if } \text{Health\_exp}_i^* > 0$$

where $Health\_exp^{*}_{ij}$ is a latent variable representing average monthly pig health expenditure in Uganda Shillings (UgX). X_i represents a vector of explanatory variables which included: farm location, education, number of household members involved in farming, number of pigs, breeds, number of full-time labour and access to veterinary services, marital status, farmers experience, other livestock species available, access to extension and credit, VSLA membership, production system and dummies for records of African swine fever, mange, worms, piglet anaemia and lice on farm. The hypothesized effects of the explanatory variables are presented in Table 1.

Results

Population characteristics

Over 85% of the pig farmers were males, while 75% of the farmers were married. Over 78% of the farmers used veterinary services, while the average monthly health expenditure on pig health management was UgX 22,300 (USD 6.4). Forty-one percent of the farmers were located in urban areas. Over 75% of the farmers were married with an average of 4 years and 17 years of pig production and farming experiences, respectively. The household heads had spent on average 7.7 years on formal schooling, with each household having on average 4.5 members involved in agricultural production. Each pig farm had on average 5.3 pigs at the time of the study, with over 3.6 full-time labourers involved in pig production. Over 15% and 22% of the farmers had access to agricultural extension and credit, respectively, while 52% were members of a VSLA. On the pig breeds kept on farm, most (51%) of the farmers kept local breeds on their farms (Table 2).

Table 2 Characteristics of study population

Variable	Mean (SD)
Access to veterinary services (dummy)	0.78 (0.41)
Health expenditure	22,304.17 (29,594.95)
Location (urban) (dummy)	0.41 (0.49)
Married (dummy)	0.75 (0.43)
Pig production experience	3.98 (3.63)
Education	7.66 (4.17)
Farm household size	4.52 (3.11)
Pig herd size	5.33 (4.20)
Access to extension (dummy)	0.15 (0.36)
Access to credit (dummy)	0.22 (0.41)
VSLA membership (dummy)	0.52 (0.50)
Local breed (dummy)	0.51 (0.50)
Crosses (dummy)	0.20 (0.40)
Exotic breed (dummy)	0.29 (0.45)
Farming experience	17.23 (12.62)
Semi intensive (dummy)	0.31 (0.46)
Extensive (dummy)	0.35 (0.48)
Intensive (dummy)	0.34 (0.47)
Full-time labour	3.60 (2.36)
Female (dummy)	0.15 (0.36)

In case of dummies, we have proportions instead of means

SD standard deviation (in parentheses)

Use of veterinary services in pig production and its determinants

Over 78% of the pig farmers had access to veterinary services from mainly (97%) private providers (Table 3). These veterinary services were used mainly for the treatment of sick animals (88%) and vaccination of animals (64%).

Factors associated with access to veterinary services in pig production are shown in Table 4. As expected, farmers with larger pig herd sizes were more likely to seek veterinary services than those with smaller herd sizes ($p < 0.05$), while those rearing exotic breeds were three times more likely to access veterinary services than those rearing only local breeds ($p < 0.05$). Farmers who were members of a VSLA were 8% more likely to access veterinary services as opposed to non-members ($p < 0.1$). Similarly, farmers using extensive production systems were 11% less likely to access veterinary services than those rearing their pigs under the semi-intensive and intensive system ($p < 0.05$). The other important factor determining access to veterinary service was the frequency of disease outbreaks on farm. Specifically, farmers who recorded disease outbreaks were more 11% more likely to access veterinary services ($p < 0.01$).

Determinants of expenditure on pig health management

Factors that determine expenditure on pig health management are shown in Table 5. As expected, farmers in urban areas were more likely to spend more on pig heath management than rural-based farmers ($p < 0.1$). Farmers with higher numbers of pigs were more likely to spend more on pig health management than those with smaller number of pigs ($p < 0.01$). There was a positive and significant influence of level of education on average health expenditure ($p < 0.01$). Similarly, the number of household members involved in farming had a positive and significant influence on health expenditure ($p < 0.05$). There was a positive relationship between incidences of diseases, such as mange and expenditure on pig health management ($p < 0.05$). On the other hand, there was a negative relationship between number of full-time labourers on the farm and pig health expenditure ($p < 0.1$).

Table 3 Access, use and source of veterinary services by pig farmers

Variable	Category	Percent
Access to veterinary services ($N = 240$)	Yes	78.33
	No	21.67
Source of veterinary service ($N = 188$)	Private vet	96.81
	Government vet	3.19
Use of veterinary service ($N = 188$)	Vaccination of animals	64.36
	Treatment of animals	88.30
	Training of animal health management	10.11

Multi-response variable, use of veterinary services, needs not add up to 100%

As opposed to local breeds, farmers who kept cross breeds ($p < 0.01$) and exotic breeds ($p < 0.05$) spent significantly less on pig health management. Farmers who had access to veterinary services spent significantly higher than those who did not use any veterinary service ($p < 0.01$).

Discussions

The management of livestock disease and other health-related issues is critical if livestock production is to contribute significantly to household income (Perry and Rich 2007; Perry and Grace 2009; Rich and Perry 2011; Chenais et al. 2017). This study assessed the determinants of pig health management interventions amongst smallholder pig farmers in northern Uganda. The predominance of private veterinary service providers amongst pig farmers in the region is due to their presence and ease of access by farmers (Tatwangire 2014). Although government veterinary services are usually available, access by farmers is usually constrained by factors such as inadequate number of veterinary staff within the vicinity of farmers. Consequently, in case of disease outbreak, farmers usually do not wait for government veterinary officers to reach them; rather, they seek the service of private veterinary

Table 4 Factors associated with access to veterinary services

Access to veterinary service		Logit regression		Marginal effects	
Variables		Coef.	Std. Err.	*dy/dx*	Std. err.
Location (1 = urban, 0 = rural)		0.645	0.530	0.058	0.049
Married (1 = married)		− 0.945*	0.490	− 0.074**	0.035
Experience in pig production		− 0.044	0.087	− 0.004	0.008
Education		− 0.082	0.056	− 0.008	0.005
Pig herd size		0.128**	0.060	0.012**	0.006
Other livestock species available		0.346*	0.186	0.032*	0.018
Access to extension		0.832	0.837	0.062	0.049
VSLA membership (1 = member)		0.808*	0.433	0.077*	0.043
Pig breeds on farm (local = base)	Crosses	0.473	0.666	0.039	0.049
	Exotic	1.407*	0.771	0.107**	0.044
Production system (semi-intensive = base)	Extensive	− 1.014**	0.512	− 0.108*	0.062
	Intensive	0.410	0.644	0.036	0.054
Number of health issues reported on farm		1.186***	0.350	0.110***	0.033
Number of health issues common in farmers locality		0.100	0.410	0.009	0.038
Constant		− 0.580	0.801		
N		240			
Log likelihood		− 83.315			
Wald chi^2 (14)		48.20			
Prob > chi^2		0.0000			
Pseudo R^2		0.3358			
GOF—Pearson chi^2 (223) = 249.67; Prob > chi^2 = 0.1062					

VIF test had mean VIF of 1.41. All the variables in this model had VIF values of less than 2, which is highly acceptable

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table 5 Factors influencing expenditure on pig health management

Explanatory variable		Coefficient	Robust std. err.
Location (1 = urban, 0 = rural)		8200.57*	4687.09
District (Omoro = base)	Gulu	− 11,309.60	10,862.96
	Kitgum	− 29,055.75*	16,276.72
Married (1 = married, 0 = otherwise)		− 5651.49	4084.68
Experience in pig production		355.07	488.41
Education		1688.93***	565.92
Household members involved in farming		1383.80**	640.62
Pig herd size		1710.59***	635.01
Other livestock species available		1730.13	2264.04
Extension		1862.34	4454.01
Credit		7335.28	7093.16
VSLA membership		− 3009.47	5852.35
Breed (local = base)	Crosses	− 14,397.42***	4737.90
	Exotic	− 9822.03**	4901.93
Farming experience		147.86	219.40
Production system (semi-intensive = base)	Extensive	5280.03	8038.70
	Intensive	919.96	3940.90
ASF ever recorded on farm		566.56	4382.26
Worms ever recorded on farm		− 115.01	6439.81
Mange ever recorded on farm		10,376.32**	4013.43
Anaemia ever recorded on farm		− 6038.46	6868.32
Lice ever recorded on farm		− 4811.84	3269.47
Full-time labour		− 1644.77*	849.61
Access to veterinary services		41,643.96***	10,868.71
Constant		− 29,743.64**	12,068.86
Sigma		29,152.48	5881.72
N		240	
Left-censored observations at $Y \leq 0$		49	
Uncensored observations at $Y > 0$		191	
Log likelihood		− 2256.11	
$F(25, 215)$		4.43	
Prob > F		0.0000	

VIF test had mean VIF of 1.65. All the variables in this model had VIF values of less than 4, which is highly acceptable

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

providers who are often a phone call away. The observation that majority of farmers were accessing veterinary services and paying for it suggest that pig farmers were cautious about the health of their pigs and took deliberate efforts to manage and pay for pig health management.

Within the rural-urban divide, there are differences in access to agricultural inputs including veterinary services. Farmers located in urban areas were more likely to access veterinary services and pay for it compared with the rural-based farmers. This finding suggests a relationship between farmer's location and pig health expenditure which is attributed to variations in the cost and accessibility of pig health–related services across locations (Kothalawala et al. 2017; Kungu et al. 2019). Farmers located in urban areas usually have better access to agricultural services and thus are more likely to use them than those in rural areas (Nkamleu and Adesina 2000; Mirajkar et al. 2011; Lamichhane and Shrestha 2012; Aubert and Enjolras 2014; Wang et al. 2019). For instance, Mirajkar et al. (2011) reported that farmer's preference for veterinary service depended on their location and distance, while Lamichhane and Shrestha (2012) reported that the distance to the nearest service provider greatly determined farmers' preference of the respective veterinary service.

Labour is an important factor for expenditure on pig health management. It is evident that if a farm has more full-time labourers—or more household members providing full-time labour for pig production—there is usually better management which implies better husbandry practices, and reduced disease incidence, thus a lower expenditure on health management. For such farms, it is expected that focus would be on prevention, which is associated with lower cost as opposed to disease control and treatment.

As the herd size increases, it is anticipated that the requirements for disease management also increase, necessitating more management engagement and focus. This explains why pig herd size had a positive and significant influence on use of veterinary services and expenditure on pig health management. This finding is consistent with those of K'Oloo et al. (2015), who reported that access to both non-trained veterinary service provider and government animal health assistant had a positive relationship with herd size. Additionally, Can and Altug (2014) reported that both technical and economic scores of biosecurity measures adopted on farm were significantly different for the categories of herd sizes.

Farmer's level of education is an important determinant of the level of knowledge and skills of the farmer. Educated farmers are better informed and hence better at decision-making and management. It is thus expected that educated farmers are more likely to spend more on pig health management since they are able know what to spend on. An earlier study by K'Oloo et al. (2015) also reported that farmers' level of education had a significant positive relationship with veterinary access from government paraveterinary officers. Similar studies by Mockshell et al. (2014) and Lamichhane and Shrestha (2012) independently reported that farmer's choice of veterinary services providers was greatly influenced by their education with more educated farmers preferring better service providers that usually cost more.

It is no doubt that membership to VSLA benefits smallholder farmers (Karlan et al. 2017). This study finds that pig farmers who are members of a VSLA had better access to veterinary services. Membership to a VSLA benefits farmers through improving access to credit and opportunities to share best practices. Consequently, pig farmers who are members of a VSLA have access to credit which they can use to pay for veterinary services for their pigs. This finding supports literature that VSLA membership can improve the business outcomes of farmers (Ksoll et al. 2016; Brannen and Sheehan-Connor 2016). Karlan et al. (2017) reported that VSLA improved business performance of rural households in Ghana, Malawi and Uganda. Additionally, Brunie et al. (2017) showed that participation in a saving group supported household investments in agricultural activities in rural Mozambique.

This study also provides evidence of how differences in livestock breeds and production systems influence livestock health management. Whereas farmers with exotic breeds or crosses were more likely to use veterinary services, they spent less on pig health management than those with local breeds. Extensive production systems are usually associated with poor access to agricultural inputs including veterinary services. This result can be explained by the fact that farmers who adopt exotic and cross-breeds are usually more market oriented than those keeping local breeds (Madzimure et al. 2012). The low access to veterinary services by farmers with local breeds can be attributed to the fact that local breeds are perceived to be well adapted to the local environment and hence resistant to parasite and diseases (Otte et al. 2012). Additionally, most farmers with local breeds tend to keep them under extensive system, where minimal attention is given to their health. Interventions to control such parasites and diseases are usually costly. Kungu et al. (2019) reported that local pigs reared under non-market-oriented system tend to have persistence of certain parasites and diseases, which are usually costly to control and prevent. This could explain why farmers with local breeds spent more on health management than those with exotic breeds. Additionally, when farmers change their market orientation (from local to improved breeds and cross-breeds), they are more likely to adopt best practices with respect to pig health management in order to increase their profitability. These findings find support in previous research such as Madzimure et al. (2012) and Kungu et al. (2019), who suggest that pig health management is dependent on the production systems adopted by the farmer. In extensive production systems, pig health management is not usually an important component of pig husbandry. Usually, such production systems are characterized by low investments in production, with farmers usually giving limited attention to pigs in terms of feeding and health management (Tatwangire 2014).

The number of health issues recorded on farm greatly determines whether farmers seek veterinary services or not. As the number of health issues reported on pig farm increases, the probability of seeking veterinary services increases. This finding is consistent with the finding on expenditure on health management which revealed that farmers who reported incidence of certain health issues on farm spent significantly more than those who do not. The incidence of parasites and diseases plays an important role in the decision to seek veterinary services and subsequently spend on health management. According to Ilukor et al. (2015), farmers who recorded the incidence of a disease of epidemic nature were more likely to contact a veterinarian and less likely to contact a paraprofessional. These findings imply that farmers' decisions on pig health management are influenced by a previous experience of disease outbreaks and management. In case of the absence of any health issues on farm, farmers' efforts towards pig health management tends to focus on prevention which is usually less costly than in the event of incidence of diseases including mange.

This study provided critical evidence on the factors associated with access to veterinary services and expenditure on pig health management. These factors are important in improving access to veterinary services for smallholder pig farmers. If farmers are encouraged to change their breeds from local to improved and change their production systems from extensive to more intensive systems, they would significantly spend less on pig health expenditure. Similarly, membership to VSLA and similar farmers groups should be encouraged as a way of improving pig farmers' pig health management and subsequently business outcomes. Deliberate efforts need to be focused on improving veterinary services in the rural areas so that they are able to compete favourably with their urban counterparts.

Conclusions

Most smallholder pig farmers accessed veterinary services from private veterinary providers. Farmer's location, labour availability, herd size, level of education, VSLA membership, breed kept, production system used and outbreak of diseases on the farm are important factors that influence smallholder farmers' access and expenditure decisions regarding pig health management. These factors have implications for the design and implementation of smallholder pig health management strategies. First, encouraging farmers to join VSLAs would provide them with the required financial access to manage pig health. Second, training and awareness creation would increase access and improve management of pig health amongst smallholder farmers. Lastly, changing farming orientation through promotion of improved breeds, expanding the herd size and adoption of more intensive production systems, would help to improve access to veterinary services and management of pig health. Further research should focus on disintegrating expenditure on pig health management by the different pig health management practices adopted on farm for the control and prevention of parasites and diseases.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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