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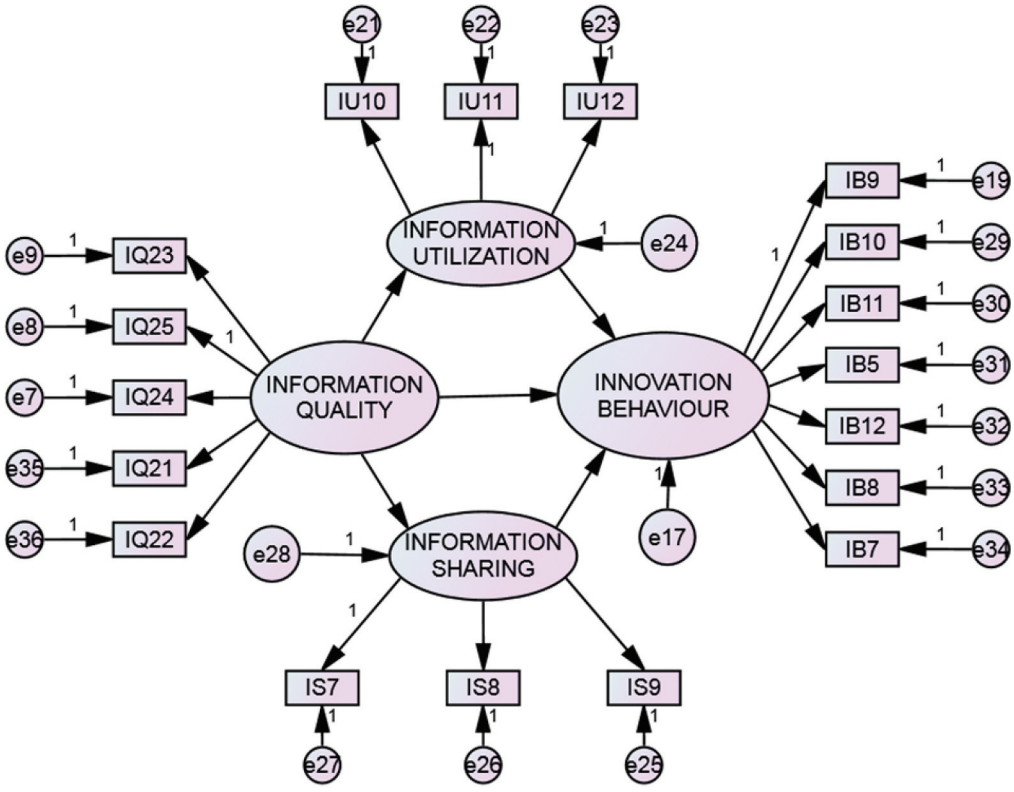

CMIN=315.611, DF=130, CMIN/DF=2.428, GFI=0.866,
AGFI=0.823, NFI=0.814, CFI=0.880, RMSEA=0.077, R-Square=0.54
Item acronyms (e.g IQ23) are described in Table 2

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FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Effect of market information quality, sharing and utilisation on the innovation behaviour of smallholder pig producers

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Abstract: Although pig farming can accelerate Uganda's economic development, the value chain is undeveloped with poorly organized informal markets. Buyers take advantage of farmers paying low prices, pointing to the poor quality of pigs and pork. Farmer innovation can remedy this situation by enabling farmers to reduce costs, improve pig productivity and quality of pigs and pork. Leveraging farmer innovation behaviour calls for appropriate agricultural information. However, the effect of market information quality, sharing, and utilization on the innovation behaviour of pig producing farmers is not fully known. This study sought to determine the effect of information quality, sharing, and utilisation on the innovation behaviour of pig producing farmers in Northern Uganda. A cross-section survey of 239 respondents selected through multiple stages of purposive and random sampling was done. Data were analysed by Structural Equation Modeling (SEM). The results show that information quality contributes significantly to innovation behaviour directly ($\beta = 0.247$; $P < 0.01$) as well as indirectly through the partial mediation of information utilization ($\beta = 0.176$; 95% CI = 0.040□0.349). Therefore, interventions that seek to enhance smallholder farmer innovation should provide quality information and support farmers to utilise it.

J. Mugonya

ABOUT THE AUTHOR

J. Mugonya is the founder and Managing Director of Mugagga Holdings Limited, a private company engaged in agricultural marketing, research and consultancy in Uganda. His research interest is smallholder farmer's innovation behaviour and transitions. He is interested in the innovations that smallholder farmers make in response to biotic and abiotic shocks and their transitions from dependency on state support or humanitarian aid for their production and consumption to self-reliance. Currently, he is working with ICRISAT and WFP to study the transition readiness of cash transfer beneficiaries in Mogadishu and Puntland, Somalia. The present paper focusing on information quality shades light on how information can be used to enhance the innovation behaviour of smallholder farmers.

PUBLIC INTEREST STATEMENT

Although information system can accelerate the development of agriculture in developing countries, the quality of the information provided by the system can be a limiting factor. If farmers get inaccurate information regarding market demand, price, growing problems and weather conditions, they make wrong production and marketing decisions which affect the profitability of their enterprises. This paper focuses on the effect of information quality, sharing and utilisation on the innovation behaviour of pig producers. It emerges that the quality (timeliness, cost-effectiveness, usability, accuracy and relevance) of information significantly affects the innovation behaviour of pig producers. Farmer innovation only succeeds if their information quality needs are met. Therefore, interventions that seek to enhance smallholder farmer innovation should provide quality information to farmers for success.

Subjects: Agricultural Development; Agricultural Economics; Agriculture and Food; Information Theory; Innovation Management

Keywords: Pig production; value chain; agricultural information systems; farmer innovation; uganda

1. Introduction

The pig sector can accelerate Uganda's economic development through the improvement of the welfare of smallholder farmers and the provision of employment (Mulindwa, 2016; Tatwangire, 2013). However, this potential is undermined by systemic market barriers, including limited access to market information, poor market linkages, inadequate access and high cost of feeds, credit and extension services (Muhanguzi et al., 2012).

Scholars have suggested that to remedy these challenges; pig producing farmers need to innovate ways of reducing costs and dependence on external inputs, improve organization, production and productivity, and quality of pigs and pork (Baliwada et al., 2017; Creaney et al., 2015; Reij & Waters-Bayer, 2001; Wiskerke & Roep, 2007). This innovation would enable farmers to increase the competitiveness and performance of their piggery enterprises and earn an income commensurate to their work in the value chain (López-fernández et al., 2016; Rojo-Ramírez et al., 2020). Still, innovation would enhance the ability of farmers to react and adapt to risks, market failures and environmental distresses (Chopeva et al., 2015). However, producer market information needs have to be met before such innovation behaviour takes root (Sousa et al., 2016).

For instance, (Kante et al., 2019) find that the use of an ICT model is highly predictive of the increased adoption of farm input information by small-scale farmers in developing countries. Several other studies have confirmed that access to market information significantly affects farmer innovation (Arshad et al., 2016, 2017; Ullah et al., 2020; Zulfiqar & Thapa, 2017). However, these studies did not consider the quality of the information and the mediating effect of information utilisation on innovation behaviour.

Opposed to the linear approach to innovation (transfer of technology), a central notion of the innovation system (IS) approach is the fact that innovation is not spontaneous, a "one-time off event" but rather a process that takes place over some time (Hermans et al., 2013; Knickel et al., 2009; Schut et al., 2015). It does not only involve technology uptake by the recipient farmers but also influences within the environment of farmers such as social support structures, markets, and other factors (Dolinska & D'Aquino, 2016). Particularly, the IS approach demands that in contributing to the innovation process, joint problem-solving and therefore participatory technology development is necessary through a discursive space for all stakeholders, namely the beneficiary farmers, scientists, change agents, and support services (Läpple et al., 2015; Leitgeb et al., 2011; Naouri et al., 2020; Reij & Waters-Bayer, 2001; Röling, 2009). It places the farmers as beneficiaries at the centre of determining their destiny in the innovation process.

This is because integrating farmers, like the smallholder pig producers, in the innovation process has been linked to stimulating farmer learning and strengthening relationships within the value chain (Vecchio et al., 2020). That is, if pig producing farmers gain a strong bargaining position in the value chain, they can develop durable, mutually beneficial social and economic relationships with other players in the market as well as demand for support services. Therefore, quality market information can enable pig producing farmers to maintain and reap from existing market linkages. For example, it enables the farmers to know and orient their production towards specific needs and wants of target buyers, who will likely reward them by paying a better price for the better quality pig products generated through innovation. The long term impact will be improved livelihood of farmers arising from enhanced specialization and efficiency in creating market value.

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Although access to quality information has been said to enable farmers to improve their livelihoods through several ways including, increasing efficiency and productivity, and supporting innovation behaviour (Ofuoku et al., 2008); there is a paucity of empirical evidence on its effect on innovation behaviour. Therefore, this study sought to examine the effect of the market information quality, sharing and utilisation on the innovation behaviour of smallholder pig producers in northern Uganda. The findings will contribute to the understanding of the effect of different constructs of agricultural information on farmer innovation behaviour.

1.1 Hypotheses development and operationalization

The model links market information quality to the innovation behaviour of pig producers both directly and indirectly via the utilisation and sharing of information (Figure 1). Innovation refers to the generation or use of a new method, idea or practice to create greater value for own satisfaction or for the customer from available resources (Brugere et al., 2020; Lowitt et al., 2020). Innovation behaviour is defined as the tendency of an individual or a business to introduce or adopt something new or the attitude towards information and market demand of innovations (Chopeva et al., 2015; Tirfe, 2014).

Farmer innovation is a technology, practice or organization along a given value chain that is different from common or traditional practice and is developed primarily by a farmer or a group of farmers with or without external assistance by extension agents, researchers, or development workers (Wu¨nscher & Tambo, 2016). Therefore, Farmer innovation behaviour is the tendency of a farmer or a group of farmers to develop new technology, practice, or organization along a given value chain with or without external support from extension agents, researchers or development workers.

Farmer innovation behaviour has four core dimensions, which include: 1) exploration [search for innovations/technology and flexibility with new alternatives]; 2) experimentation [the propensity to try out new technology and observe subtle changes]; 3) modification [improvement of existing practices]; 4) adaptation [improvement of new practices to suit the farmers' situation] (Baliwada et al., 2017; Bragdon & Smith, 2015; Creaney et al., 2015; Lowitt et al., 2020; Popadiuk & Vidal, 2009; Tambo & Wünscher, 2014; Vecchio et al., 2020; **Wettasinha et al.,**2014 Mugonya et al., 2020).

H_1: Market information quality has a significant positive effect on information utilisation.

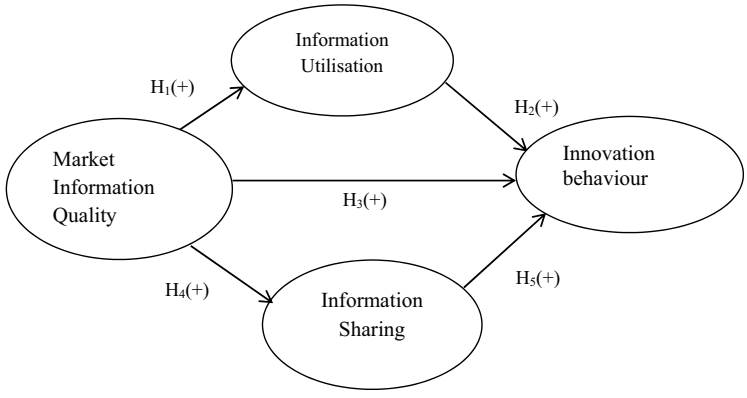

Figure 1. Conceptual framework.

Quality information has been defined as that with objectivity in presentation and substance, utility and integrity or security (Jonsson & Myrelid, 2016; USPTO, 2014). Information quality is a multi-dimension construct with four domains including intrinsic, accessibility, contextual, and representational (Floridi, 2013; Wilson et al., 2021). These domains are broken down into thirteen attributes which are; i) accuracy, objectivity, and believability for the intrinsic dimension, ii) access and security for accessibility dimension, iii) relevance, value-added, timeliness, completeness and amount of data for the contextual dimension, iv) interpretability, ease of understanding, concise representation and consistent representation for the representational dimension (Floridi, 2013; Kumar & Jakhar, 2010; Ofuoku et al., 2008).

The subject of investigation for this study regarding information quality was on five attributes for convenience and clarity to the respondents. The attributes were operationalized as timeliness [the extent to which information is up to date and is accessible on time for its planned use], cost-effectiveness [the degree to which information access is affordable by the user], usability [the ease of understanding information and thus being able to apply it], accuracy [the extent of user's perception of information as correct and reliable] and relevance [the level of match between supplied information and that which is required to make a decision] (Acheampong et al., 2017; Kumar & Jakhar, 2010; Ofuoku et al., 2008). The utilisation of information for the intended purpose is hampered if the source does not give credible and quality information. For example, in an adoption study, (Schipmann-Schwarze et al., 2014) contend that access to extension officers is not the major barrier to farmers being informed about improved varieties. It is rather the quality of the information provided by extension officers that play a role in adoption. If extension officers are accessible but are not well informed about improved varieties, awareness and by extension adoption of improved varieties will remain low. Therefore, information quality is posited to have a direct positive effect on information utilisation

H_2: Information utilisation positively affects innovation behaviour

In most cases, information utilisation tends to ignite the spirit of curiosity and creativity among users (Keh et al., 2007; Tadesse, 2008). Therefore farmers with high levels of innovation behaviour are likely to be active in information utilisation. For this reason, information utilisation is hypothesized to positively impact innovation behaviour. Also, because the acquisition of quality information is irrelevant without its application by receivers, information utilisation is postulated to be a partial mediator of the relationship between information quality and innovation behaviour.

H_3: Market information quality has a direct positive relationship with innovation behaviour

Information is a vital resource in farming practice, and quality information enables farmers to improve their livelihoods in several ways, including supporting innovation. Therefore quality information is expected to have a direct positive effect on pig producers' innovation behaviour.

H_4: Market information quality positively affects information sharing

Information sharing is the exchange of critical information amongst chain partners (Li et al., 2005). It has two dimensions, connectivity and willingness (Marinagi et al., 2015) and delivers value based on four features including content, frequency, direction, and modality (Jonsson & Myrelid, 2016). Quality information is more likely to be shared and applied by intended users (Marinagi et al., 2015). Therefore it is postulated that information quality has a positive relationship with information sharing.

H_5: Information sharing mediates the relationship between market information quality and innovation behaviour

(Chindime et al., 2017) argue that information sharing enhances the innovation performance of farmers. Therefore, information sharing is expected to positively impact pig producers' innovation behaviour.

2. Methodology

2.1. Description of the study area

The study was conducted in Paicho sub-county, Gulu district, and Koro sub-county, Omoro district, Northern Uganda, between October and November 2018. The geographical coordinates are 2.8186° N, 32.4467° E and 2.7152° N, 32.4920° E for Gulu and Omoro respectively. In this area, most farmers are smallholders with an average landholding of two acres per household and the majority of pig rearing households keep between 6 to 20 pigs. Pigs are largely managed through tethering, feeding on locally available fodder and/or domestic food residues with 60% of the labour provided by women (Ikwap et al., 2014). The study took place in a setting in which pigs have been prioritised by many interventions for transforming farmer livelihoods. As such, several government programs have been supplying pigs to farmsteads as a way of achieving increased production. Some of these programs include the National Agricultural Advisory Services (NAADS), Northern Uganda Social Action Fund (NUSAF) and the Youth Livelihood Program (YLP).

2.2. Research design and sampling

The study employed a cross-sectional survey because time and financial resources available could not support longitudinal or experimental study. A multi-stage sampling technique was used to select study participants. First, two districts and then one sub-county per district were all selected purposively. Sub-counties of Paicho (Gulu district) and Koro (Omoro district) were selected. With only 8.9% of households keeping pigs, Gulu district (mother district of Omoro) was rated among the districts with the lowest number of pig rearing households in the northern region of Uganda (Tatwangire, 2014). Yet, pigs and pork in these administrative units have been reported to have a lucrative market and high turnover (Ikwap et al., 2014). Paicho and Koro sub-counties were both identified by their respective district production offices as the sub-counties with the highest number of pig rearing households in the district.

Second, three parishes[1] that benefited from the NAADS program were purposively selected from each sub-county. In Paicho sub-county, Pagik, Kal-umu and Kal-ali parishes were selected, while in Koro sub-county, Pageya, Labwoch and Guna parishes were selected. Third, a complete list of all pig rearing households in the selected parishes that benefited from the NAADS program was obtained from the respective sub-county headquarters. The list had 393 farmers from Paicho and 201 from Koro constituting a sampling frame to 594 pig producing farmers. Fourth, systematic sampling was used to select the study sample of 239 respondents; the number which was determined using Yamane's formula (Yamane, 1967):

$$n = \frac{N}{1+Ne^2}\ , n = \frac{594}{1+\left(594x0.05^2\right)}\ , n = 239 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{Equation 1}$$

Where; N = population, n = Sample size, e = Degree of confidence level at 95%. The 239 respondents were distributed between Paicho and Koro in portions of 143 and 96 pig producing farmers, respectively.

2.3. Data collection

Before data collection, the study obtained approval from Gulu University Research Ethics Committee (GUREC) under application number GUREC-094-18. Face to face interviews were conducted using a pre-tested structured questionnaire. Pre-testing was done on ten pig producing farmers in Unyama Sub-county because the area had many pig producing farmers and was near

the study area, yet it was not part of the study. After the pretest, some amendments were made in the questionnaire, such as re-wording, and re-ordering of some questions to ensure clarity, logical question sequence, and instruction adequacy. Informed consent was sought from every respondent before commencing the interview. The questionnaires were administered in the local dialect (Acholi), but responses were recorded in English.

The questionnaire comprised of closed and Likert scale questions in which participants were requested to rate various items to ensure the clarity of the questions to the respondents for easy answering. The data collection tool consisted of three sections. Section one captured household socio-economic data including, age of the household head, education level, sex, household size, marital status, non-farm employment and group membership. Section two focused on information quality, sharing and utilisation. Market information quality data were collected using 15 items capturing the five attributes of the construct. The farmers' rating concerning cost-effectiveness, usability, timeliness, accuracy and the relevance of market information was recorded on a five-point Likert scale. A sample item from the dimension of timeliness reads as; "in case of a disease outbreak, the information reaches me fast enough to enable me to take appropriate actions".

The data on information sharing were collected with six items capturing the two dimensions of information sharing which include connectivity and willingness as adapted and modified from (Marinagi et al., 2015; Yusuf, 2012). A sample item from the dimension of willingness reads as; "I share pig price information with peer farmers". Data on information utilisation were gathered by six items that captured the action-oriented use of information by respondents as adapted and modified from (Marinagi et al., 2015; Yusuf, 2012). A sample item from this construct reads as follows; "I use buyer information to make decisions on where to sell pigs." All items were rated on a 5-point Likert scale where 0 = not at all, 1 = rarely, 2 = occasionally, 3 = frequently and 4 = always as adapted with modifications from (Sullivan & Artino, 2013).

Lastly, in the third section, farmer innovation behaviour was captured under the four dimensions of innovation behaviour namely: i) exploration, ii) experimentation, iii) adaptation of new pig rearing techniques/ practices, and iv) modification of existing farm practices as adapted with modification from previous research (Ajayi et al., 2018; Aubert et al., 2012; Coussy, 2015; P. Wilson et al., 2014). A total of 12 items were used to collect data on innovation behaviour. Each item was rated on a 5-point Likert scale where 0 = not at all, 1 = rarely, 2 = occasionally, 3 = frequently and 4 = always as adapted with modifications from (Sullivan & Artino, 2013). Sample items on innovation behaviour include: i) from the dimension of exploration "I am very curious about learning how to appropriately feed pigs"; ii) experimentation "I like to experiment new ways of erecting pig housing structures"; iii) adaptation "I adjust new parasite and disease control practices to suit my farming situation" and modification "I use new knowledge to modify existing pig feeding practices on the farm".

2.4. Data analysis

The exploratory factor analysis was done to reduce the number of items for each construct to obtain the best fit model. This was achieved by principal component analysis using Varimax rotation with Kaiser Normalization, a criterion of eigenvalue over one and suppressing items with a factor loading of 0.4 in SPSS. Correlations were run among the specified constructs to test for the existence of postulated associations and rule out the possibility of multicollinearity, which would impede the use of SEM for analysis (Swati & Rajib, 2015).

The tight-fighting set of components was imported to AMOS for subsequent analysis using Structural Equation Modeling (SEM) for Confirmatory Factor Analysis (CFA) of hypothesized the relationships. SEM was used because it enables simultaneous estimation of multiple cause-effect relationships among various predictor, mediating, and response variables (Kalule et al., 2019; Swati & Rajib, 2015).

Convergent validity that measures the contribution of each observable variable to the total variance of a construct was tested using factor loadings and Average Variance Extracted (AVE).

Table 1. Respondents' socio-economic profile (n =239)

Variable	Result
Age (Average years)	37.73
Household size (Average number of persons)	7.02
Education level (Average years in school)	7.21
Gender (1 =Male)%	73.64
Distance to the trading centre/market (Average Km)	1.12
Received extension visit in the last 12 months (1 =Yes)%	35.98
Access to credit (1 =Yes)%	34.31
Group membership (1 =Yes)%	52.30
Off-farm employment (1 =Yes)%	57.74
Pig rearing experience (Average years)	4.25
Pig stock (Average number of pigs)	5.78

Table 2. Measurement properties and correlations

Construct	AVE	CR	1	2	3	4
1. Information Quality	0.496	0.808	0.704 [c]			
2. Information Sharing	0.501	0.883	0.205	0.708 [c]		
3. Information Utilisation	0.519	0.822	0.244	0.057	0.720 [c]	
4. Innovation behaviour	0.500	0.878	0.375	0.168	0.476	0.707 [c]

Values on the diagonal with superscript "c" = √AVE

Construct reliability was assessed using composite reliability (CR). Discriminant validity was tested by comparison of the square root values of AVE with values of construct correlations. The independent variables, in this case, were information quality, information sharing, and information utilisation while the dependent variable was the innovation behaviour of pig producing farmers. The mediation analysis was done to ascertain whether the hypothesized mediation among the variables existed.

3. Results

Most respondents (73.64%) were males and a small number had access to credit (34.31%) and extension services (35.98%) [Table 1]. Farmers attributed the low access to extension service to the limited number of government agricultural extension staff covering a large area of the administrative units in this study.

The KMO value was 0.831, and Bartlett's Test of Sphericity was significant (Chi-Square: 1496.415, df: 153, Sig. 0.000). A KMO value above 70% suggests that the data is fit for factor analysis (Kaiser, 1974). The total variance explained was 68.245%. The Average Variance Extracted of the independent variables and the dependent variable reached the threshold of 0.5. All constructs had composite reliability of above 0.7 (Table 2). Therefore acceptable convergent validity and measurement reliability of all the constructs in the model was achieved (Hair et al., 2017)

Table 3. Factor loadings of items of the study constructs

Items	Factor Loadings			
	Information Quality	**Information Sharing**	**Information Utilisation**	**Innovation behaviour**
IQ 21: In case of a disease outbreak, the information reaches me quick enough	0.659			
IQ 22: I can meet the cost of pig rearing information that I get	0.762			
IQ 23: I get accurate price information	0.734			
IQ 24: The buyer information I get enables me to accomplish pig sales more quickly	0.675			
IQ 25: The information I get is consistent with my need for improving pig rearing practices	0.686			
IS 7: I share buyer information with peer farmers		0.731		
IS 8:I share pig product-quality requirement information with peer farmers		0.659		
IS 9: I share pig price information with peer farmers		0.731		
IU 10: I use buyer information to make decisions on where to sell pigs			0.523	
IU 11: I use product-quality information to make decisions on when to sell pigs			0.736	
IU 12: I employ price information to make decisions on whether to sell live pigs or pork			0.472	
IB 5: I take part in training on new methods of pig rearing				0.615
IB 7: I like to try out new ways of erecting pig houses				0.794

(*Continued*)

Table3. (*Continued*)

Items	Factor Loadings			
	Information Quality	**Information Sharing**	**Information Utilisation**	**Innovation behaviour**
IB 8: I like to try out new practices of pig feed management				0.856
IB 9: I clearly understand how to modify existing pig rearing practices				0.877
IB 10: Modification of existing pig rearing practices to suit my situation is easy				0.533
IB 11: I adjust new pig housing practices to suit my situation				0.587
IB 12: I alter new pig feeding practices to fit my situation				0.708

All the square root values of AVE were greater than the correlations, which confirmed the discriminant validity of the constructs. The correlates ranged from weak to moderate (r = 0.057 to r = 0.476) pointing to the existence of relationships amongst the study variables. Since there was no high correlation amongst the variables, then the assumption of "no multicollinearity" was confirmed. Altogether, the construct items achieved the required threshold of factor loading of 0.5 [Table 3] (Hair et al., 2009).

The model exhibited an acceptable level of fit as observed from the fit indices (Figure 2) going by (Hair et al., 2017; Awang, 2015; Hair et al., 2010) who recommended that for a good fit, the Goodness of Fit Index (GFI) > 0.8; Adjusted Goodness of Fit Index (AGFI) > 0.8; Normed Fit Index (NFI) > 0.8 and Root Mean Square Error of Approximation (RMSEA) < 0.08.

Results of hypothesis testing in Table 4 show that market information quality (β = 0.245; P < 0.01) is a positive and significant predictor of marketing information utilisation for innovation. Market information utilization (β = 0.794; P < 0.01) positively and significantly predicts farmer innovation behaviour. As predicted, information quality directly affects innovation behaviour (β = 0.247; P < 0.01). Information quality positively affects information sharing (β = 0.194; P < 0.05). The path from information sharing to innovation behaviour is positive but non-significant.

The mediation effect of information utilisation (β = 0.176; 95% CI = 0.040□0.349) between information quality and farmer innovation behaviour was significantly different from zero (Table 5). The biggest significant total effect on innovation behaviour is exerted by information utilisation (β = 0.643; 95% CI = 0.482□0.782) followed by information quality (β = 0.375; 95% CI = 0.137□0.527). The two findings meet the criterion of practical relevance of β ≥ 0.2 (Kalule et al., 2019). Also, the causal relationship between information quality and information utilisation (β =0.244; 95% CI = 0.057□0.442) was statistically significant and satisfied the requirement of practical meaningfulness. The direct relationship between information quality and farmer innovation behaviour (β = 0.199, 95% CI = 0.137□0.527) was significant and met the criterion of practical relevance while that between information sharing and innovation behaviour (β = 0.096; 95% CI = −0.051□0.255) was not significant.

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Figure 2. Effect of information quality, sharing and utilisation on innovation behaviour.

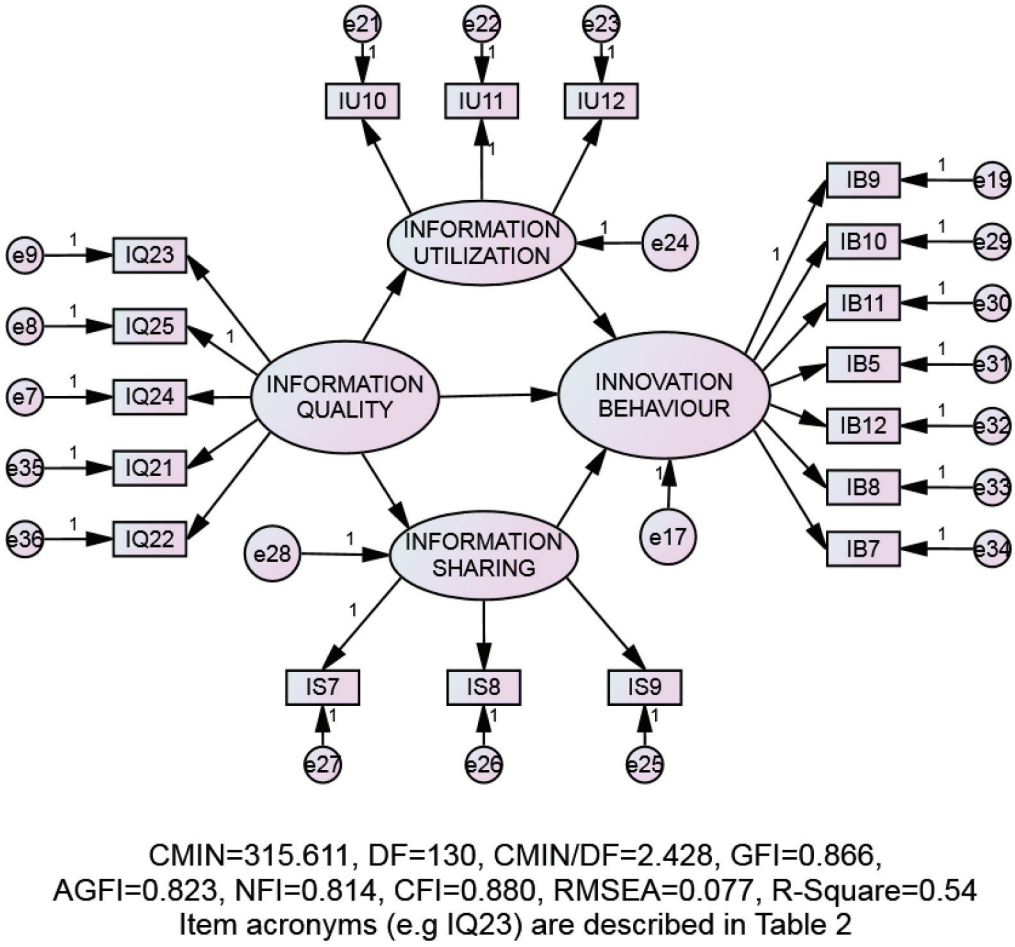

Table 4. Regression results from SEM model

Regression path	β	t-value	Hypothesis decision
H_1: Information quality→Information utilisation	0.245	2.599**	Supported
H_2: Information utilisation→Innovation behaviour	0.794	6.093**	Supported
H_3: Information quality→Innovation behaviour	0.247	2.623**	Supported
H_4: Information quality→Information sharing	0.194	2.358*	supported
H_5: Information sharing→Innovation behaviour	0.125	1.418	Not supported

*Significant at $P \leq 0.05$, **Significant at $P \leq 0.01$

Table 5. Bootstrapping for mediation test

Paths	Standardized effects			Bias-corrected 95% CI	
	Direct	**Indirect**	**Total**	**Lower bound**	**Upper bound**
Info. quality→Info. utilisation	0.244	-	0.244	0.057	0.442
Info. utilisation→Innov. behaviour	0.643	-	0.643	0.482	0.782
Info. quality→Info. sharing	0.205	-	0.205	0.036	0.370
Info. sharing→Innov. behaviour	0.096	-	0.096	− 0.051	0.255
Info. quality→Innov. behaviour	0.199	0.176	0.375	0.137	0.527
Info. quality→info. utilisation→Innov behaviour	-	0.176	0.176	0.040	0.349

4. Discussion

As predicted by (Jonsson & Myrelid, 2016), results of hypothesis testing presented in Table 4 show that information quality positively affects information utilisation ($P < 0.01$), implying that farmers who receive quality information are likely to use it to alter their pig production and marketing activities for better gains than those who do not get quality information.

Also, the results revealed that market information utilisation positively affects innovation behaviour ($P < 0.01$). Farmers who use market information to make decisions on how to rear pigs tend to have a higher innovative activity, which translates into better competitiveness. This finding is in line with the study by (Uwandu et al., 2018) in which agricultural information utilisation was found to enhance farmer innovativeness in Imo State, Nigeria. Related studies by Adetimehim et al., 2018 in Indo State, Nigeria, Acheampong et al., 2017 in Ejisu-Juaben Municipality of Ghana and (Aonngernthayakorn & Pongquan, 2017) in central Thailand confirmed a relationship between access to extension service and utilisation of agricultural information. Therefore, to enhance farmer innovation through information utilisation, policymakers need to improve access to extension service by farmers.

Predictably, information quality was found to have a direct positive relationship with innovation behaviour ($P < 0.01$). This suggests that farmers who access quality information are more able to explore new ideas, experiment, adapt new practices, and improve existing pig rearing practices than those who do not have access to quality information. This is attributable to the fact that quality information is relevant, accurate, timely and usable which prompts users to utilise it.

Consistent with previous research by (Marinagi et al., 2015), information quality was positively related to information sharing ($P < 0.05$). This result points to the fact that quality information is more likely to be shared amongst the users of the information. This could be attributed to the fact that quality information is relevant, timely and usable which makes recipients trust it and share it with their peers.

In contrast to a previous study by (Chindime et al., 2017), information sharing among pig producers had no significant effect on their innovation behaviour. (Chindime et al., 2017) reported that information sharing among farmers through networking had a positive significant effect on their innovation behaviour. This discrepancy is perhaps because the previous study did not consider the quality and utilisation of the information being shared. This finding indicates that sharing of quality information among farmers does not necessarily affect their innovation behaviour unless the information is put into use. The result further supports the argument that ambiguous information-sharing causes information overload which reduces the potential of small producers to use the information for innovation (Jonsson & Myrelid, 2016; Wesseler & Brinkman, 2002). Therefore, information sharing performs no mediation role in the relationship between information quality and innovation behaviour as shown by bootstrapping results (Table 5).

Interestingly, information utilisation predicts up to 64.3% (Table 5) of the variance in farmers' innovation behaviour which implies that information utilisation is the single most important information factor affecting farmer innovation behaviour. Therefore, interventions to boost farmer innovation should enhance information utilisation by farmers through institutional support such as extension service provision.

5. Conclusion and recommendations

Market information quality enhances farmer innovation behaviour both directly and indirectly through the partial mediation of information utilization. It can be argued that the quality of market information received and its utilisation at the farm level is important for the kind of innovation behaviour that smallholder pig producers exhibit. Therefore, interventions that seek to enhance smallholder farmer innovation should provide quality information and support farmers to utilise it.

An extension of the study would be to analyse the effect of other dimensions of information utilisation such as knowledge enhancing use and affective use of information on the innovation behaviour of farmers. It may also be worthwhile to put the study in a longitudinal perspective to understand how these influences play out in the long run and discern how the interventions to improve the pig value chain should be tackled using information systems and farmer innovation approach.

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Competing interests
The authors declare that they have no conflict of interest.

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Note
1. A parish is the second-lowest political-administrative unit in Uganda consisting of several villages. For instance, Pagik parish comprises 10 villages.

Disclosure
All authors actively participated in the research and article preparation, and have approved the final article.

Data Availability Statement
The data that support the findings of this study are available from the corresponding author, [J. Mugonya], upon reasonable request.

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