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*Corresponding author: Cosmas Nonga, Department of Food Science and Agro-processing, School of Engineering and Technology, P.O. Box 3006, Morogoro, Tanzania; email: cosmashezron1@gmail.com

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ANIMAL HUSBANDRY & VETERINARY SCIENCE | RESEARCH ARTICLE

Assessment of compliance with Good Agricultural Practices in pig farming in Mpwapwa and Mbulu districts, Tanzania

Cosmas Nonga^{1*}, Issa Zacharia¹, Ernatus Mkupasi² and Helena Ngowi²

Abstract: A cross-sectional study was conducted between February and May 2022 to explore the pig farming practices and assess their compliance with Good Agricultural Practices (GAPs) and their associated constraints in Mpwapwa and

ABOUT THE AUTHORS

Cosmas Hezron Nonga is a graduate of MSc. in food quality and safety assurance at the Department of Food Science and Agro-processing, School of Engineering and Technology in Sokoine University of Agriculture. Currently, he is the Research Assistant in the area of post-harvest management and value addition at the Tanzania Agricultural Research Institute (TARI) in Dodoma, Tanzania. At the research institute, he is officially obliged to design, plan and develop various research proposals in the cereals and grapes value chain to reduce post-harvest losses while offering the diversification and development of various nutritious food products in Tanzania. Moreover, he is competent and involved proactively in data collection, analyses, and is the author of the research findings, these make him act as the junior researcher and consultant in his obliged areas of the research investigations in Tanzania.

Dr. Issa-Zacharia Abdulsudi is currently a Senior lecturer at the Department of Food Science and Agro-processing, School of Engineering and Technology, Sokoine University of Agriculture (SUA). He is an author and co-author of over 32 publications in scientific peer-reviewed journals. He has extensive knowledge in Food Processing, Food Security, and Food Safety, with over 16 years of experience in the field. At the University he is involved in research, teaching both graduate and undergraduate programs; supervising undergraduate research projects, master and Ph.D. theses, outreach, and consultancy.

Dr. Ernatus Martin Mkupasi, is a Senior Lecturer in the Department of Veterinary Medicine and Public Health, Sokoine University of Agriculture (SUA) in Tanzania. He was awarded a Bachelor of Veterinary Medicine and a Master of Veterinary Medicine majoring on Veterinary Public Health from Sokoine University of Agriculture in 2001 and 2008, respectively. Dr. Mkupasi was then awarded a PhD from Copenhagen University in Denmark in 2013 specializing on parasitic zoonoses. His expertise and research interest are in the area of Veterinary Public Health and Food Safety. Dr. Mkupasi has published widely in national and international peer reviewed journals. He currently involved in research looking forward to develop practical, low cost and community acceptable *Taenia solium* cysticercosis control tools in Tanzania.

Helena A Ngowi is an Associate Professor at the Department of Veterinary Medicine and Public Health, Sokoine University of Agriculture (SUA), Tanzania, specializing in veterinary public health. She has worked extensively in health promotion approaches to control parasitic diseases transmissible between animals and humans. H. Ngowi has conducted several high-profile research studies on the prevalence, transmission and risk factors of porcine cysticercosis caused by *Taenia solium*, including various field intervention trials. H Ngowi has also trained in epidemiology and qualitative research and has developed different health education materials including leaflets, posters, training manuals and video programmes. She has published more than 90 scientific articles to date, including review articles, books and book chapters. Being a veterinary public health researcher and trainer, H. Ngowi collaborate in various multidisciplinary projects, including those researching on aspects that include social and medical fields, a one health approach in research and disease control. She has been consulted by WHO and OIE on ad hoc basis for matters related to development of disease control guidelines.

Mbulu districts. A total of 136 pig farmers were randomly chosen from purposively selected wards for interview using a structured questionnaire. The study revealed that 71.3% of all pig farmers were aware of GAPs on pig farming, but only 19.8% of the pig farmers complied with the stipulated GAPs. About 81.6% of the respondents had poor piggery hygiene and 76.5% had poor piggery conditions. Pig farmers reported the cost of feeds (83.8%) and veterinary services (81.6%) to be the hindrance to compliance with GAPs. It was concluded that pig farmers are aware of GAPs but not all implement them. Limited availability and high costs of pig feeds and veterinary services are among the factors limiting the full implementation of GAP in pig farming in the Mpwapa and Mbulu districts. Therefore, there is a need for the Ministry of Livestock and Fisheries Development and private investors to collaborate to ensure accessibility to Agro-vet services in rural areas with minimal cost. A positive effect could also result from encouraging pig farmers to use locally available ingredients to compose pig feeds.

Subjects: Agriculture; Agriculture and Food; Food Laws & Regulations

Keywords: pig farming; Good Agricultural Practices; veterinary services; animal feeds

1. Introduction

Pig farming is one of the important agricultural activities being performed by different communities as a source of food and for income generation. It is marked as the primary production stage in the pork value chain and is concerned with all activities of rearing an animal until it is ready for slaughter (Rahman et al., 2008). In the past, pigs were kept in small numbers and closely associated with the residence of the owner, or in the same village or town (Blumetto Velazco et al., 2013). For decades, intensive pig production has been adopted around the globe, and it takes place in confinement for feeding (Misinzo et al., 2012). However, some rural communities' free-range or semi-intensive systems are still practiced and the production is dominated by small-scale pig farmers thus contributing to the large number of pigs that are available in the market (Valverde et al., 2021).

Modernization in the global food system has brought a demand for quality and safe food production. The quality of pork depends on the overall health status of a pig which is influenced by the farming system (Jang et al., 2020). Good Agricultural Practices are a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social, and environmental sustainability (FAO, 2016). Adoption of Good Agricultural Practices (GAPs) is preferred for effective pig farming, as well as ensuring the safety and quality of the produced pork (Yona et al., 2020). GAPs include proper pig management systems, such as good pig housing conditions and proper feeding. The pig pen should have enough space, made of materials that are easy to clean such as raised timbers or concrete floor, and proper waste management. Also, it includes measures to prevent and control diseases like vaccination and biosecurity (Okocha et al., 2018). Animal nutrition is also an important aspect to be considered for the better health and growth of an animal (Chauhan et al., 2016; Fang, 2022). The GAPs requirements and guidelines for proper livestock keeping are also well highlighted and recommended in the Tanzania Animal Disease Act of 2003, the Livestock Policy of 2006, and the Animal Welfare Act of 2008 (Ministry of Livestock and Fisheries, 2022).

Pig farming is highly practiced in different parts of Tanzania and several studies have reported common production constraints of pig farming in developing countries to be high mortality rate, absence or minimal health care, free-range feeding, and poor pig housing conditions, as well as

poor hygiene which at large affect quality and safety of pork and facilitates the spread of pig diseases such as African Swine fever and *Taeniasis* (Mkupasi et al., 2013; Nonga & Lugendo, 2015; Nyangi et al., 2022). Repeated Outbreaks of diseases such as African Swine-fever and *T. solium* cases have been reported as an outcome of poor pig management in Tanzania (Lekule & Kyvsgaard, 2003; Mkupasi et al., 2013; Ngowi et al., 2019). Thus pose a health threat to consumers and reduces the market value for pork. Nevertheless, information on the compliance status of pig farming practices concerning GAPs in Tanzania is still limited. Thus, this study was conducted to determine the compliance of the smallholder pig farmers concerning GAPs in Mpwapwa and Mbulu.

2. Materials and methods

2.1. Study areas and duration

The study was carried out from February to May 2020 in Dodoma and Manyara regions. Geographically, Dodoma Region is located at latitudes 6° 57' and 3° 82' South and longitude 36° 26' and 35° 26' East, in the central part of Tanzania. Administratively, the Dodoma Region is divided into seven districts that include Dodoma, Chemba, Kondoa, Chamwino, Mpwapwa, Bahi, and Kongwa. According to the 2002 national census, Dodoma Region had a population of 2,083,588 people and Mpwapwa District had 305,056 people. Mpwapwa District was selected due to the presence of a large number of smallholder pig farmers (NBS, 2012). According to district Livestock office data 2021, the population of pigs in Mpwapwa is 66,607, contributing significantly to the pork consumed in Dar es Salaam and Dodoma cities (Mkupasi et al., 2017).

Manyara Region is located at latitude 3° 36' 0" South, 35° 56' 0" East, in the northern part of Tanzania. According to the 2012 national census, Manyara Region had a population of 1,425,131. Administratively, the region has seven districts, which are Babati districts, Babati Town, Hanang, Kiteto, Mbulu, and Simanjaru. Mbulu District with a total population of 320,279 was also selected due to the high number of smallholder pig farmers (NBS, 2012). According to district Livestock office data for 2020, Mbulu District had 21,292 pigs and its main market is in Arusha city.

2.2. Study design and population

A cross-sectional study design was used whereby pig farmers were visited once and the questionnaire was administered. The study population involved a random selection of pig farmers from the Mpwapwa District in Dodoma and the Mbulu District in the Manyara Region. The inclusion criteria included pig farmers who kept at least two pigs, located in the accessible areas and willingness to participate in the study. The exclusion criteria included: unwillingness to participate in the study, being unable to give the information asked, and living in inaccessible areas.

2.3. Sample size and selection of study participants

The sample size for pig farmers was estimated by the equation for an unknown population (Kothari, 2004): $n = z^2 (1-p)/e^2$ Where: n = size of the sample, z = standard variate at 90% confidence level (1.645), p = the standard deviation of population and e = acceptable error which was taken at 10% (0.1). Therefore, 136 pig farmers formed the sample size and were distributed as 68 for Mpwapwa and 68 for Mbulu.

2.4. Ethical consideration

A research permit was sought from the Vice Chancellor of Sokoine University Agriculture and the Executive Directors of Mpwapwa and Mbulu District Councils. Before the interview, verbal consent was obtained from each participant after explaining the purpose and importance of the study. Participation in the study was voluntary. All the information collected from the participants and the laboratory results obtained after the pork sample analysis were kept under the custody of the researcher as confidential.

2.5. Sociological data collection

Sociological data were collected using a structured questionnaire and observational checklist. The questionnaire was provided with closed-ended sections for each of the pig farmers to fill. The information collected from pig farmers included pig housing and management, feeding systems, hygiene of piggeries, and disease control measures. The provided information was verified through the observational checklist. For determination of the level of compliance with GAPs in pig farming, observational and structured questions were used. The majority of the questions had pre-coded responses (closed-ended questions), and a few had open-ended questions. Also, an observational checklist was used based on the guideline and requirements.

2.6. Sampling plan and data collection from pig farmers

A multistage sampling technique was used to obtain the smallholder pig farmers as follows: The first stage involved the selection of study wards in Mpwapwa District and Mbulu. Mpwapwa district consists of 33 wards, which were listed down, and purposively four wards were selected based on the presence of the high number of smallholder pig farmers, namely, Chitemo, Mazae, Berege, and Mpwapwa for Mbulu District which has 18 wards, four wards were randomly selected which include Yaeda Ampa, Tumati, Dongobesh, and Haydom.

The second stage involved a purposive selection of villages based on the number of smallholder pig farmers from the study wards and a simple random selection of smallholder farmers from the selected villages. A total of 16 villages were selected from the Mpwapwa District and 16 from the Mbulu District to make a total of 136 pig farmers.

2.7. Data analysis and interpretation

Awareness of farmers on GAPs for pig farming was based on disease prevention and control, piggery condition, hygiene, pig management, and type of feed used. Each response was given a “1” score for “Correct” and “0” for “incorrect.” The cumulative score of the 5 aspects ranged from 0 to 5 points. Overall awareness on GAPs pig farming was categorized as being aware of whether the score was between 60% and 100% (3 to 5 points) and not aware if the score was less than 60% (3< points). Each pig farmer’s practices in the checklist were categorized as either YES (Good practices) or NO (Poor practices). Each good practice observed was awarded a “1” point, while every poor practice was awarded a “0” point. The cumulative score of the checklists ranged from 0 to 5 points for a particular pig farmer. Overall compliance with good pig farming practices was categorized as good if the score was between 60% and 100% (3 to 5 points) and poor if the score was less than 60% (3< points) (Seid & Hussien, 2018).

Table 1. Socio-demographic characteristics of the pig farmers (N = 136)

Parameter	Category	Number (%) of respondents
District	Mpwapwa	68(100.0)
	Mbulu	68(100.0)
Gender	Male	85 (62.5)
	Female	51 (37.5)
Age	25–35	33 (24.3)
	36–45	43 (31.6)
	Above 45	60 (44.1)
Education level	Non-formal education	27 (19.9)
	Primary	62 (45.6)
	Secondary	36 (26.5)
	College/University	11 (8.1)
Number of pigs	<50	135 (99.3)
	50–100	1 (0.7)

Table 2. Awareness status of pig farmers on GAPs n (%)				
Parameter	Category	Aware	Not aware	P-value
District	Mpwapwa	50 (73.5)	18 (26.5)	0.57
	Mbulu	47 (69.1)	21 (30.9)	
Gender	Male	59 (69.4)	26 (30.6)	0.52
	Female	38 (74.5)	13 (25.5)	
Age	25–35	22 (66.7)	11 (33.3)	0.47
	36–45	29 (67.4)	14 (32.6)	
	Above 45	46 (76.7)	14 (23.3)	
Education level	Non-formal education	18 (66.7)	9 (33.3)	0.21
	Primary	41 (66.1)	21 (33.9)	
	Secondary	27 (75.0)	9 (25)	
	College	11 (100)	0 (0.0)	
Number of pigs	<50	96(71.1)	39(28.9)	1.00
	50–100	1(100)	0	

Figure 1. Appearance and hygiene status of piggeries observed from small-scale pig farmers.



Raw data established from questionnaires and observational checklists were entered and stored in an Excel spreadsheet. The data were processed and analysed using a Statistical Package for Social Science (SPSS version 20.0). A descriptive statistic that involved frequencies, percentages, and cross-section tabulation was used to check the awareness and compliance of pig farmers as well as constraints to compliance with GAPs. Chi-square and Fisher exact tests were used to check the association between variables and P-values at a 95% level of significance.

3. Results

3.1. Socio-demographic characteristics of pig farmers

A total of 136 pig farmers were interviewed in the Mpwapwa District ($n = 68$) and Mbulu District ($n = 68$), and the socio-demographic information of the pig farmers are shown in Table 1. It was found that the majority of the pig farmers (62.5%) were males, aged below 45 years (55.9%) and most of them (45.6%)

Table 3. Performance of pig farmers on Good Agricultural Practices

Parameter	Category	Frequency n (%)
Type of management/feeding	Confinement	105(77.2)
	Free range/scavenging	31(22.8)
Housing type	Concrete/raised timber	32(23.5)
	Earthened/trees	104(76.5)
House cleanliness	Clean	25(18.4)
	Dirty	111(81.6)
Diseases control/prevention (vaccine and antibiotics)	Always	59(43)
	Not always	77(56)
Feed type	Compounded	10(7.4)
	Non Compounded	126(92.6)

Table 4. Compliance status of pig farmers' n (%)

Parameter	Category	Comply	Not comply	P-value
District	Mpwapwa	14(20.6)	54(79.4)	0.83
	Mbulu	13(19.1)	55(80.9)	
Gender	Male	19(22.4)	66(77.6)	0.34
	Female	8(15.7)	43(84.3)	
Age	25–35	5(15.2)	28(84.8)	0.68
	36–45	10(23.3)	33(76.7)	
	Above 45	12(20)	48(80)	
Education level	Non-formal education	2(7.4)	25(92.6)	0.00*
	Primary	8(12.9)	54(87.1)	
	Secondary	6(16.7)	30(83.3)	
	College/University	11(100)	0	
Number of pigs	<50	26(19.3)	109(80.7)	0.20
	50–100	1(100)	0	

N=136, P-value with * were significant at 95% level.

had attained primary education. Assessment of farming practices showed that 99.3% ($n = 135$) of the respondent were small-scale pig keepers who kept less than 50 pigs.

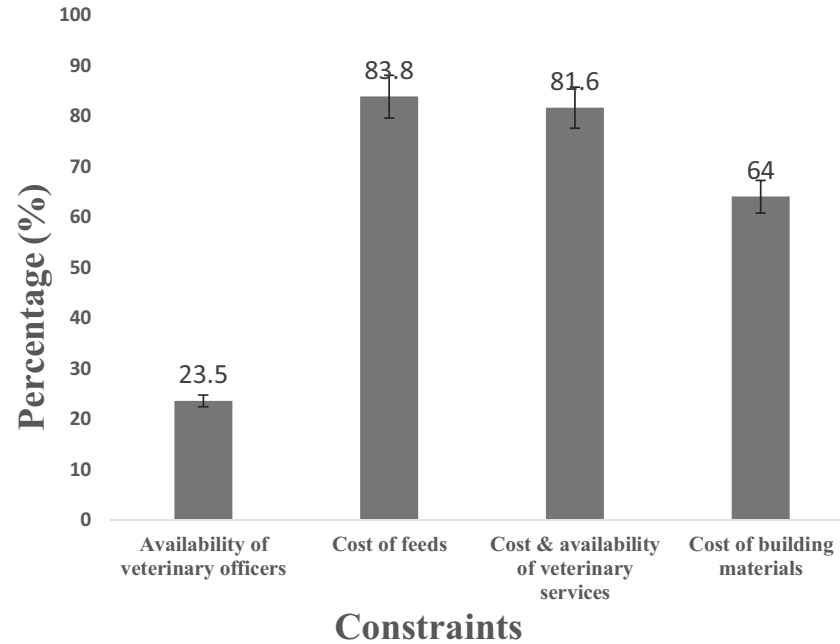
3.2. Awareness status of pig farmers on Good Agricultural Practices (GAPs)

Table 2 shows the results on the awareness status of farmers on Good Agricultural Practices. The results showed farmers of both districts were aware of the GAPs and there was no significant difference in the level of awareness of farmers on GAPs ($P = 0.57$ at 95% level) between Mpwapwa and Mbulu districts (73.5% and 63.1% respectively). Also, the comparisons on awareness of GAPs among pig farmers based on gender, age, education level, and the number of pigs showed no significant association.

3.3. Performance of pig farmers on Good Agricultural Practices

This study revealed that the majority of the respondents had poor piggery hygiene (81.6%) and poor piggery condition (76.5%) as shown in Figure 1, followed by poor disease control strategy (56.6%). The study shows that pig farmers complied with good pig management and feeding system (77.2%) as they kept their pigs in confinement, only (22.8%) had poor pig management systems by practicing free-range feeding systems (Table 3).

Figure 2. Constraints to compliance with GAPs by pig farmers.



3.4. General compliance of pig farmers with Good Agricultural Practices

The results show that in both districts, the majority of farmers did not comply with GAPs for Mpwapwa and Mbulu (79.4% and 80.9% respectively) did not comply with the required GAPs. Nonetheless, there was no significant difference ($P=0.83$ at 95%) in compliance status between Mpwapwa and Mbulu districts. Also, the study revealed that gender and age had no association with the compliance status of the respondents on GAPs in both districts (Table 4). This study shows that all pig farmers with College/University education complied with GAPs and the level of education had an association with the compliance status of pig farmers since the P-value ($P=0.00$ at 95% level). In addition, there was no association between compliance and the number of pigs kept by the respondent ($P=0.20$ at 95% level) as shown in Table 4.

3.5. Constraints to compliance with GAPs by pig farmers

The major constraints to compliance with GAPs were the cost of feeds at 83.8% and veterinary services at 81.6% followed by the cost of building materials by 64%. Availability of veterinary officers was not a major problem for pig farmers as only 23.5% was selected as a constraint for compliance with GAPs as shown in Figure 2.

4. Discussion

The study was conducted to determine the compliance status of pig farming practices and the major constraints to compliance with GAPs in the districts of Mpwapwa and Mbulu. The findings of this study show that males dominate pig farming. This could be because in many African societies, men are regarded as owners of livestock possessed in a household. This was supported by a study done by Karimuribo et al., (2014) in Iringa and Kabululu et al., (2015) in Mbeya, who reported that males were more engaged with pig farming activities compared to females. Small-scale pig farming is dominating pig production in Tanzania whereby about 99.3% of pig farmers had less than 50 pigs. This implies that pig keeping could be an avenue for livelihood improvement in many rural communities. The fewer pigs kept per household could be attributed to the limited financial capital needed for the farmers to establish and sustain commercial pig farming to realize the full economic potential of the industry. This was similar to a study by Mkupasi et al., (2013) and Kimbi et al., (2016) who reported that a large number of pig farmers in Sub-Saharan countries are based

on a small scale, and pig husbandry is considered an important source of income for some of rural societies for poverty reduction in their rural life.

The study found that most farmers were aware of GAPs in pig keeping and management. Statistical results show that the level of education did not influence the awareness level of pig farmers as even the s farmers with primary and non-formal education were also aware. The high level of awareness observed during this study could be attributed to the education provided by livestock extension officers who work closely with pig farmers. Furthermore, some pig farmers mentioned experiences from neighbour farmers and radios as other sources of information concerning the GAPs on pig farming. GAPs are highly recommended by local and international food control and management systems to ensure quality and safety at the primary production stage. These findings were similar to the study by Jennifer et al., (2022) reported the impact of extension officers on the improvement of the livestock sector by educating farmers concerning modern farming techniques in China.

Despite the high level of awareness of pig farmers on GAPs, this study revealed that there is a gap between knowledge and practices on GAPs as the majority of pig farmers did not comply with GAPs. Poor piggery conditions and poor hygiene were observed as most of the piggeries were made up of tree logs with earthen floors which hinder cleaning and pig waste management, thus resulting in the accumulation of fecal waste and water in the pen. The design of the piggery, management, routine cleaning, and good housekeeping are important factors in maintaining good hygiene (Mlowe et al., 2022; Tobunluepob et al., 2014). Cleaning was not done regularly by farmers, leading to an outbreak of diseases like diarrhea and skin conditions affecting pig performance. Similarly, a study by Nonga and Lugendo. (2015) reported that unsanitary conditions expose pigs to diseases and reduce their resistance to infection, allowing disease to spread and hence affecting growth and the overall quality of the pork.

In addition, the study shows that feeding was not done per the guidelines for GAPs on pig farming which point out the consideration of animal nutrition through the use of compounded feeds with proper feed formulation which includes mineral supplements (Habibi et al., 2021). The majority of pig farmers were based on non-compounded feed that constituted maize bran, green leaves, potato peels, and kitchen wastes. Pig feeding is one of the important requirements for GAPs in pig production since pigs need nutritious feed with the inclusion of mineral supplementation to boost their growth, reproduction, and production efficiency (Czech et al., 2022; Lin et al., 2020). Higher protein and energy diets facilitate animal growth to reach an acceptable market weight at a recommended age. Moreover, a well-fed pig will have strong immunity which helps to resist diseases (Yona et al., 2020).

The study further observed that farmers' levels of education were significantly associated with their GAP compliance status. Farmers with a College or University education were more likely to comply with the GAPs for raising pigs compared to less educated farmers. This could be to their high knowledge of the impact of practicing GAPs in their pig farming activities. These findings also indicate a significant association between the number of pigs and GAPs compliance status of farmers, and this was influenced by the level of investment, as a farmer with more than 50 pigs adhered to GAPs requirements for pig farming. This agreed with other studies that reported that poor farming practices were aggregated by pig farmers' low investment and level of education. Thus, supporting small farmers with profitable capital for investment as well as more infancies on improving the education level of rural farming communities will help to improve the pig farming sector in Tanzania. A sustainable supply of good-quality pigs will ensure pork availability and public health and contribute to the improvement of the farmer's economy as well as the Gross Domestic Product (GDP) for the country. Furthermore, the study shows that the cost and availability of veterinary services and building materials are the major constraints to compliance with GAPs among pig farmers, consequently resulting in poor piggery conditions, hygiene, and disease control for the majority of farmers. Similar results were reported by Hirwa et al., (2022) and Okello et al., (2022) in Rwanda and Uganda, respectively, which pointed out that the cost and availability of veterinary services in most African countries are influenced by limited Agro-vet shops in rural areas. Although the costs of good quality feeds and their limited availability were mentioned as one of the constraints in proper pig feeding, very few farmers practiced free pig

ranging. The main reason for this finding is the strict by-laws implemented in the villages which force the farmers to confine their pigs to avoid conflicts with other farmers who conduct crop cultivation and it is only highly implemented during cropping season. A sustainable supply of good quality feeds should be implemented by incorporating input suppliers in the policy reformation for improving the pig farming sector in Tanzania.

5. Conclusion and recommendations

The pig farming sector in Tanzania is still at a lower stage with a poor and traditional pig management system as farmers are aware of the importance of GAPs for pig farming but their practices seem not achievable. Also, the availability of Agro-vet services is still challenging for the pig farming sector and hence retarding the efforts of small-scale farmers. Therefore, there is a need for livestock policy reformation to support farmers' transformation to profitable pig farming as the market depends on them for pig availability. Potential investors, financial institutions, and government should collaborate to improve the pig farming sector in Tanzania. Finally, the resources to livestock officers for implementation of general livestock guidelines, policies, and regulations should be enhanced.

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Author details

Cosmas Nonga¹

E-mail: cosmashezron1@gmail.com

ORCID ID: <http://orcid.org/0000-0003-0445-3472>

Issa Zacharia¹

Ernatus Mkupasi²

Helena Ngowi²

¹ Department of Food Science and Agro-Processing, School of Engineering and Technology, Morogoro, Tanzania.

² Department of Veterinary Medicine and Public Health, College of Veterinary Medicine and Biomedical Science of Agriculture, Morogoro, Tanzania.

Disclosure statement

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