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Husbandry practices among peri-urban free-roaming pigs in Gert Sibande District Municipality, Mpumalanga, South Africa

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Abstract

Interactions at the human-animal-environment interface have increased significantly as a result of globalisation, increased urbanisation, environmental degradation, and the growing need for animal-based foods, leading to the growth of peri-urban agriculture. We investigated peri-urban free-roaming pig (FRP) production husbandry practices to identify production constraints in a district municipality in South Africa. A total of 124 pig farmers were identified using the snowball technique and interviewed. Statistical analyses were performed using SPSS V28.0. Most of the FRP farmers were men (70.2 %), aged ≥ 36 years (80.7 %), and individuals with ≤ high school education (84.6 %). The majority (75.8 %) did not have a weaning protocol, and a large proportion (93.5 %) conducted peri-urban FRP without permission from the local authority and were not registered for animal identification (72.6 %). Over 94.4 % of the farms didn't employ routine disinfection and were unaware of transboundary animal diseases and zoonosis (87.1 %). Most pigs in the study area (72.5 %) were exotic breeds or their crosses, and most sows (51.6 %) farrowed 6-10 piglets per litter. Exotic breeds or their crosses weaned larger litters (>11) compared to indigenous breeds. Pigs scavenging in residential areas had a significantly higher risk of theft and accidents. The widespread poor husbandry practices among FRP farmers provide an opportunity to develop tailored risk communication and community engagement materials for farmers and communities. Municipalities should adopt a fit-for-purpose peri-urban livestock policy, with clear incentives and penalties to promote animal identification and good practices. Given the potential for pigs to spread disease to humans, good practices will reduce the risk of humans contracting diseases from animal-derived food.

Keywords: constraints, pig production systems, scavenging pigs, South Africa, zoonosis

1 Introduction

Recent trends of globalisation, increasing urbanisation, encroachment into previously uninhabited areas, anthropogenically related environmental degradation, growing demand for animal-based foods, increasing prevalence and levels of poverty, and the consequent need for households to adopt alternative livelihood strategies, including the rearing of free-range pigs and other livestock in peri-urban areas are major realities of the modern times (Mngumi, 2016). These have significantly increased interaction between humans, domestic pigs, other livestock, and wildlife.

Between 2008 and 2017, it was estimated that 10 - 20 % of the global food supply came directly from urban/peri-urban agriculture (Graefe *et al.*, 2008; Omondi *et al.*, 2017). Due to increased competition for land resources as a result of increased urbanisation and human movement, there is less pasture available in peri-urban areas, hence monogastric animals are more commonly kept as livestock than ruminants (Phiri *et al.*, 2003; Mekuriaw & Asmare, 2014; Chauhan *et al.*, 2016). Poor peri-urban farmers tend to raise high-fertility, fast-growing pigs to meet household food needs and resource security needs by contributing to the food supply of urban and peri-urban households. Basically, monogastric animals such as pigs differ from ruminants in a number

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of ways, including rapid growth, excellent feed conversion, ease of housing and marketing, small land requirements, high fertility, high meat protein content, ability to thrive even when free roamed, and adaptability to a range of climatic conditions.

Free-roaming pig (FRP) farming in urban and peri-urban areas is legal in South Africa. However, experts recommend overnight housing, a form of enclosed restriction, even for the FRP farming to offer protection against weather and theft (intensive system; FAO, 2009). Pig farming in urban and peri-urban areas is permitted in South Africa. However, the pigs in urban/peri-urban should be reared in an enclosed setting (DAFF, 2024), a factor the farmer has neglected, opting instead for free-roam pig farming. As a result, rearing FRP is widely practiced in South Africa's peri-urban areas, particularly in the Mpumalanga province (Amar *et al*., 2021). These pigs scavenge in the open sewage and garbage dumps, and according to Munzhelele *et al*. (2024), free-roaming pigs are sometimes even fed with dead chicken. However, swill [1] remains the main source of feed for scavenging pigs. Free-roaming pigs can carry parasites, including zoonotic ones that directly affect humans (Munzhelele *et al*., 2024), and can be a problem in the human food system, especially in cases where pigs are slaughtered at home without pre-slaughter inspection (Munzhelele *et al*., 2015). Pigs reared in a free-roaming setting typically have higher mortality rates, slower growth, lower reproductive rates, poorer health care, inadequate feed, and are more susceptible to inbreeding and inadequate shelter than intensively reared pigs.

Pig production depends mainly on good management, including feeding, housing, appropriate breeds and biosecurity, particularly in areas like Mpumalanga where the risk of African swine fever (ASF) outbreaks in peri-urban areas is high. The high risk of transmission of diseases such as ASF is due to intense movement of people and animals in and out of peri-urban areas, as well as the widespread practice of feeding swill, a high number of free-roaming and scavenging pigs, illegal slaughter of pigs, and trade of pig products within the community (Amar *et al*., 2021).

It is estimated that 7.8 million people will move to South African cities by 2030 (NPC, 2013). The National Development Plan (NDP) proposed that cities become the driving force of economic growth through increased social participation and economic efficiency. According to additional forecasts, in 2050, the proportions of people in urban/ peri-urban areas will nearly triple to 70 % (United Nations, 2018). As urban populations grow, there will be increased pressure on limited food sources, intense competition for limited resources, and challenges in meeting the needs of a healthy urban population (Mwasi *et al*., 2017). Thus, peri-urban agriculture and free-roaming livestock practices are likely to increase as the human population grows.

Previous work in the peri-urban area has documented inappropriate waste management, lack of water for the animals, lack of high-quality feed, poor livestock health management, high veterinary expenses, and low output levels due to inadequate management (Guendel & Richards, 2002). To overcome the identified challenges, peri-urban pig farming must be revolutionised using appropriate farming technologies, and fit-for-purpose relevant laws and regulations (Mwasi *et al*., 2017). Therefore, this study was conducted to investigate the peri-urban FRP management practices and to identify production constraints in Gert Sibande District Municipality of Mpumalanga province, South Africa. The findings of this study could be used to improve FRP production in peri-urban settings, which in turn could help address food scarcity, food poverty and reduce the risk of disease outbreaks in peri-urban areas.

2 Materials and methods

2.1 Description of the study area

The Gert Sibande District Municipality (GSDM) is situated in Mpumalanga province. It covers 31 846 km^2 (41 % of the province's land area) and is the largest district in the province. The district is made up of the seven municipalities, namely Chief Albert Luthuli (CALM), Msukaligwa, Govan Mbeki, Mkhondo, Dipaliseng, Lekwa, and Pixley ka Seme (Fig. 1). Zulus and Swatis make up the two major ethnic groups in the district.

2.2 Sampling and method of data collection

The number of pig farmers in GSDM is unknown. Therefore, it was not possible to develop a sampling frame; hence the snowball sampling approach was adopted to identify the participants. To cover all the peri-urban study areas, abstract transects were used to select different starting points from which snowballing started, and as many perspectives as possible were covered along each transect. Data was collected using a structured questionnaire. The questionnaire consisted of both open- and closed-ended questions. To ensure data consistency and avoid repetition, ArcGIS Survey123 (https://survey123.arcgis.com/) was utilised to gather data and map the sampled area. A total of 124 peri-urban FRP farmers were identified, signed a consent form and agreed to voluntarily participate in the study.

[1] Food leftovers from households, restaurants, hotels, bakeries, food processing plants, fruit and vegetable markets and other locally available sources.

2.3 Data analysis

Data was extracted from ArcGIS Survey123 and imported into Microsoft Excel. Coding and analysis of data was performed using SPSS V28.0 (IBM Corp, 2021). Descriptive statistics were displayed as percentages and frequencies for categorical variables. Cross-tabulation of proportions was used to examine the association between categorical variables. In addition, the correlation between variables in the peri-urban free-roaming pig system was assessed.

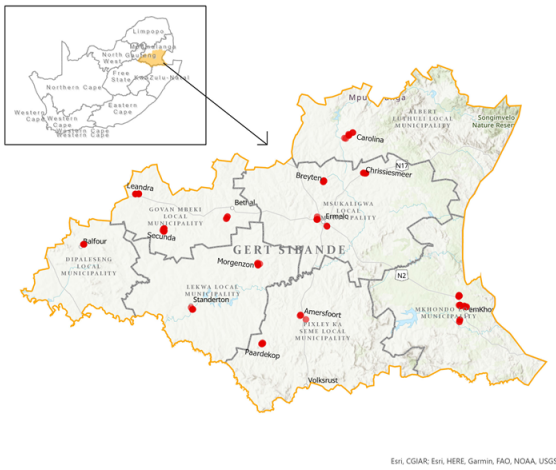

Fig. 1: *Map showing seven municipalities under Gert Sibande District Municipality*
Source: *DARDLEA Information Technology Unit.*

Table 1: *Demographics of the peri-urban free-roaming pig farmers, Gert Sibande District Municipality, South Africa (n=124).*

Variables	*Percentage*
Gender	
Male	70.2
Female	29.8
Age (years)	
18–35	19.4
36–59	45.2
>60	35.5
Monthly income	
None (not regular)	25.0
<R1000	12.9
R1001–R2000	33.9
R2001–R5000	16.1
R5001–R10000	8.1
R10001–R20000	4.0
Highest level of education	
None	16.1
Primary	25.8
Secondary	42.7
Passed matric	12.9
>Diploma	2.4
Size of the household	
Alone	4.0
2	8.9
3–5	41.1
6–10	40.3
>11	5.6

3 Results

3.1 Characteristics of the peri-urban free-roaming pig farmers in of Gert Sibande District Municipality

The practice of rearing peri-urban FRP in GSDM was dominated by male farmers (70.2 %). Very few (18.4 %) people between the ages of 18 and 35 were involved in FRP farming, while the majority of farmers were between the ages of 36 and 59. In terms of monthly income, 46.8 % of the farmers earned ≤ R2000[2] monthly and 25 % were without regular income. The majority of households (81.4 %) had three to ten members (Table 1).

3.2 Pig farming attributes of free-roaming system of Gert Sibande District Municipality

Farmers who only reared livestock made up the majority of the respondents (58.1 %), while 41.9 % reported to practice mixed farming. All pig farmers surveyed owned some additional livestock (Table 2).

[2]One Rand is equivalent to € 0.049 or US $ 0.053 as of 3rd April 2025.

Piglets were present on 64.5 % of the farms and most sows farrowed 6-15 piglets, of which approximately 65 % reached weaning, although weaning often lacked a set age (75.8 %).

3.3 Free-roaming pigs and management practices in the peri-urban areas of Gert Sibande District Municipality

Most farmers (93.5 %) operated without land ownership, and pigs frequently roamed across roads during the day (66.9 %). While nearly all farmers (98.4 %) house pigs overnight, only 62.9 % conduct home slaughtering (Table 3). Housing structures vary, with 41.9 % using corrugated metal shelters and 19.4 % having no shelter. Biosecurity practices are limited, as 94.4 % do not use disinfectants, and 72.6 % lack animal identification registration (Table 3). Awareness of transboundary animal diseases (TADs) is low (12.1 %). Theft (69.4 %) and predation (31.5 %) pose significant threats. Feeding sources and disease control measures are inconsistent, affecting overall pig health and production sustainability (Table 3).

Strong positive correlation existed between scavenging pigs and pigs walking across the roads ($r = 0.760$; $p<0.01$).

Table 2: *Profile of peri-urban free-roaming pig farms in Gert Sibande District Municipality, South Africa.*

Variables	*Percentage*
Type of farming system practiced	
Livestock farming only	58.1
Mixed farming	41.9
*Type of pig breeds**	
Exotic breed & their crosses	72.6
Indigenous breed	32.3
Exotic crosses × indigenous breed	19.4
Type of livestock	
Pigs	100.0
Cattle	40.3
Poultry	48.4
Sheep	4.8
Goat	31.5
Other†	6.5
Number of pigs per respondent	
1–5	11.3
6–10	17.7
11–15	24.2
16–20	15.3
21–30	17.7
31–50	10.5
>51	3.2
Piglets present during the survey	
Present	64.5
Absent	35.5
Number of piglets farrowed / sow	
1–5	4.8
6–10	51.6
11–15	42.7
>16	0.8
Number of piglets weaned / sow	
1–5	15.3
6–10	63.7
>11	21.0
Age at weaning	
No specific weaning age	75.8
≤35 days	5.6
36–60 days	18.5
Breeding boars	
Breeding boars (Yes)	44.4
Breeding boars (No)	55.6
Number of breeding sows	
<5	19.3
6–10	70.2
>11	10.5

*Some farmers kept a mixture of exotic breeds and their crosses, indigenous breed, and cross of exotic breeds x indigenous breeds, so these are counted more than once. †Other included rabbits, turkey and ducks. Exotic breeds and their crosses (offspring of different exotic breeds).

Weak to moderate positive correlations existed between mortality due to predation and each of scavenging pigs (r = 0.328; p<0.01) and pigs walking across the roads (r = 0.413; p<0.01) (Supplementary Table 1). Very weak but positive correlations existed between pig theft and each of scavenging pigs (r = 0.227; p = 0.11), pigs walking across the roads (r = 0.185; p<0.04) and mortality due to predation (r = 0.191; p<0.03). Almost all the evaluated variables were weakly to moderately negatively correlated, except experiencing pig theft which was very weakly positively correlated (Supplementary Table 1).

In the peri-urban free-roaming of Gert Sibande District Municipality, the probability of exotic breeds and their crosses to wean larger litter sizes (>11) was higher than that of indigenous and indigenous/exotic crosses (17.5 % and 16.7 %, respectively). Similarly, litters of the exotic breeds and their crosses were more likely to be weaned within 1 - 2 months (30 %) compared to the litters of the indigenous and indigenous/exotic crosses 17 % and 8.4 %, respectively (Table 4).

4 Discussion

This study explored the peri-urban free-roaming pig (FRP) management practices and identified production constraints in the Gert Sibande District Municipality (GSDM), Mpumalanga, South Africa. Key constraints included inadequate shelter, which exposes pigs to harsh conditions and increased disease vulnerability, limited veterinary support for disease management, and uncontrolled free-roaming practices that heightened disease risks and biosecurity issues. Additionally, weak preventive measures and insufficient biosecurity contribute to disease spread, while financial constraints limit farmers' ability to improve production and adopt better practices. Despite carrying out the full duties on the home front (cooking, nurturing, and other home management), women also participated in most of the daily pig farming tasks in households that owned them; yet, these women receive minimal support in terms of beneficial animal production training, income allocation from livestock sales and extension services to aid their skills development (Carter *et al*., 2017; Wati *et al*., 2022).

Although 98.4 % of respondents reported providing overnight pens, their adequacy is questionable due to poor materials, difficulty in cleaning, and inadequate heating systems for piglets (Chiduwa *et al*., 2008; FAO, 2009; Bröde *et al*., 2013; Mabuya & Scholes, 2020). While materials for pig housing should be affordable, durable, and flexible (Region & Tracey, 2018), competition for materials with human housing needs makes this challenging. Moreover, cold winters and hot summers in the survey area (with temperatures ranging from -1°C to over 30°C) exacerbate these issues. It is unclear if the lack of investment in durable housing is linked to the high proportion of farmers (93.5 %) not owning land or having official permission. Compliance with environmental and health regulations, such as the Air Quality Act (2004) and the Waste Act (2008), is also challen-

Table 3: *Management practices and challenges of peri-urban free-roaming pigs in Gert Sibande District Municipality, South Africa.*

Variables	*Percentage*	*Variables*	*Percentage*
Type of land ownership		*Do the pigs walk across the road?*	
Owning	4.8	No	33.1
Leasing	1.6	Yes	66.9
Farming without permission	93.5		
Do you house pigs overnight?		*Do you slaughter at home?*	
No	1.6	No	37.1
Yes	98.4	Yes	62.9
Type of house		*If yes, do you request state vet to perform inspection?*	
None	19.4	No	58.9
Corrugated house with roof	41.9	Yes	3.2
Fence with corrugated roof	4.8	Not applicable	37.9
Fence without roof	3.2		
Wood house with roof	21.0		
Wood with plastic roof	1.6		
Wood without roof	8.2		
Type of soil in the house		*Do you make use of disinfectant?*	
Concrete	19.4	No	94.4
Woods	1.6	Yes	5.6
Soil	79.0		
Are you registered for animal identification mark?		*If you use disinfectant, what do you use?*	
No	72.6	Not applicable	94.4
Yes	25.0	Dip	1.6
I don't know	2.4	Jeyes fluid/Jik bleach*	3.2
		Water with salt	0.8
If registered, do you tattoo the pigs?		*Are you aware of any transboundary animal diseases (TADs)?*	
No	21.8	No	87.1
Yes	3.2	Yes	12.1
Not applicable	75.0	No data	0.8
How do you identify your pigs?		*If you know TADs, please specify*	
None	74.2	Not applicable	87.0
Ear notch, tag or tattoo	8.1	Forgot the name	2.4
Tail docking	2.4	Foot and Mouth Disease	0.8
Cut half of the ear	9.7	African Swine Fever	8.0
Other	5.6	Tuberculosis	0.8
Do you know where your pigs get feeds?		*Experienced mortality due to accident?*	
No	63.7	No	50.8
Yes	33.1	Yes	16.9
No opinion	2.4	Not applicable	32.3
Not applicable	0.8		
Mortality due to predation?		*Age at 1st gestation*	
No	68.5	Unknown	57.2
Yes	31.5	6–8 months	12.1
		9–11 months	5.6
		≥12 months	25.1
What causes predation in pigs?		*Do you castrate the pigs?*	
Not applicable	70.2	No	66.1
Dogs	21.8	Yes	33.9
Wild animals	3.2		
Dogs and bitten by people	1.6	*Theft experience*	
Dogs and poisoned	1.6	No	30.6
Unknown	1.6	Yes	69.4

*Jeyes fluid is an outdoor cleaning fluid. Jik bleach is a detergent used to remove stains in clothes. Other: just by looking and their colour. The active ingredients in the chemical are: Jeyes fluid [(p-chloro-m-cresol (p-chlorocresol) + (Poly-) alkylphenols + Propan-2-ol (isopropyl alcohol) + Terpineol)] / Jik (Sodium Hypochlorite).

Table 4: *A cross-tabulation illustrating the relationship between the breeds and total number of piglets weaned, the breeds and age at weaning in peri-urban farming.*

Variables		*Total number of piglets weaned per sow?*		
Breed	*Number of piglets*	*1–5 piglets*	*6–10 piglets*	*>11 piglets*
Exotic breed and their crosses	90	(n=9) 10 %	(n=59) 65.6 %	(n=22) 23.4 %
Indigenous breed	40	(n=8) 20.0 %	(n=25) 62.5 %	(n=7) 17.5 %
Cross of exotic × indigenous breed	24	(n=4) 16.7 %	(n=16) 66.7 %	(n=4) 16.7 %
Variables		*Age at weaning by breed*		
Breed	*Number of piglets*	*No weaning*	*≤ 35 days*	*36–60 days*
Exotic breed and their crosses	90	(n=63) 70 %	(n=6) 6.7 %	(n=21) 23.3 %
Indigenous breed	40	(n=33) 82.5 %	(n=1) 2.5 %	(n=6) 15 %
Cross of exotic × indigenous breed	24	(n=22) 91.7 %	(n=1) 4.2 %	(n=1) 4.2 %

Note: Percentages and numbers were based on respondents.
Dichotomy group tabulated at value 1. >11 piglets = 11 piglets and above. n = number. ≤ 35 days = piglets weaned at or before 35 days. No weaning = weaned after 61 days or the piglets stay with the sow until sold or moved to be raised as porkers.

ging for smallholder farmers. In view of this, some authors have suggested that a scalable approach could promote better compliance (Öhlund *et al*., 2017; Delsart *et al*., 2020).

Biosecurity in peri-urban FRP farming needs strengthening. Only 5.65 % of respondents used disinfectants, with the majority using ineffective mixtures that may not meet manufacturer guidelines. Additionally, soiled floors in 79 % of pig houses made disinfection difficult, which is a source of concern due to the potential of the buildup of pathogens due to the inability to disinfect the sties (Kimbi *et al*., 2015; Motsa'a *et al*., 2021). In light of the ongoing ASF outbreaks in Mpumalanga, effective biosecurity is particularly highly needed in FRP production systems to minimize the risk of outbreaks and also the spread of the disease in the event of an outbreak.

There is a notable gap in knowledge of disease control among FRP farmers. This needs to be addressed by the Department of Agriculture, Rural Development, Land and Environmental Affairs during the extension services (FAO, 2008; Kouam *et al*., 2020; Singh *et al*., 2023).

Pig farming in the study area is predominantly male-dominated, similar to findings from other regions in South Africa (Munzhelele *et al*., 2017; Matabane *et al*., 2015). In contrast, female participation is higher in Kenya (Kagira *et al*., 2010; Mwasi *et al*., 2017). Free-roaming pig farming is labor-intensive, particularly for women if they have to collect swill from various sources to supplement pig feed. This raises the possibility that farmers in GSDM engage in pig farming as a last resort or they have other sources of income to support their families. Only 33.1 % of respondents are aware of where feed for their pigs was sourced from, and nearly 70 % allowed pigs to roam roads in search of food, increasing the risk of theft and accidents. These findings suggest that confinement and a shift towards more intensive farming systems are necessary for improved management (Fualefac *et al*., 2014; Mbuthia *et al*., 2015; Kouam *et al*., 2020).

Despite being an important source of livelihood and its role in food security for peri-urban populations, peri-urban FRP farming requires further investment. Government support may be necessary to scale up these operations and address the risks associated with FRPs, including disease transmission, theft, accidents, and zoonotic risks. Scavenging pigs can contaminate public water sources and spread diseases like rabies through predation (Madec *et al*., 2010; Chenais *et al*., 2019; Makovska *et al*., 2023). The case of rabies reported in Bushbuckridge (Weyer *et al*., 2020) underscores the potential dangers of FRPs.

5 Conclusion

The present investigation demonstrated that peri-urban FRP farming is widespread in the Gert Sibande District Municipality. Though FRP farming has potentials to improve livelihoods and aid food security, it faces many constraints. The reorganisation sector is imperative, and relevant official support, legislations and policies are necessary to optimise benefits associated with FRP farming in Gert Sibande District Municipality of Mpumalanga province.

Availability of data and materials

The corresponding author can provide the study's data upon reasonable request.

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Ethical considerations

The ethical approval for this work was granted by the University of South Africa's College of Agriculture and Environmental Science under the references 2019/CAES_HREC/108 and REC-170616-051. The National Department of Agriculture in South Africa granted its approval for Section 20 under reference number 12/11/1(1237).

Conflict of interest

The authors declare that there is no conflict of interest.

References

Amar, S., De Boni, L., de Voux, A., Heath, L., & Geertsma, P. (2021). An outbreak of African swine fever in small-scale pigs, Gauteng, South Africa, July 2020. *International Journal of Infectious Diseases*, 110 Suppl 1, S44–S49. doi: 10.1016/j.ijid.2021.04.003.

Bröde, P., Krüger, E. L., & Fiala, D. (2013). UTCI: Validation and practical application to the assessment of urban outdoor thermal comfort. *Geographia Polonica*, 86(1), 11–20. doi: 10.7163/GPol.2013.2.

Carter, N. A., Humphries, S., Grace, D., Ouma, E. A., & Dewey, C. E. (2017). Men and women farmers' perceptions of adopting improved diets for pigs in Uganda: decision-making, income allocation, and intra-household strategies that mitigate relative disadvantage. *Agriculture and Food Security*, 6, 1–24. doi: 10.1186/s40066-017-0095-7.

Chauhan, A., B.H.M., P., Maurya, R., Kumar, S., Shukla, S., & Kumar, S. (2016). Pig production system as a source of livelihood in Indian scenario: an overview. *International Journal of Current Microbiology and Applied Sciences*, 5, 2089–2096.

Chenais, E., Lewerin, S. S., Boqvist, S., Ståhl, K., Alike, S., Nokorach, B., & Emanuelson, U. (2019). Smallholders' perceptions on biosecurity and disease control in relation to African swine fever in an endemically infected area in Northern Uganda. *BMC Veterinary Research*, 15(1), 279. doi: 10.1186/s12917-019-2005-7.

Chiduwa, G., Chimonyo, M., Halimani, T. E., Chisambara, S. R., & Dzama, K. (2008). Herd dynamics and contribution of indigenous pigs to the livelihoods of rural farmers in a semi-arid area of Zimbabwe. *Tropical Animal Health and Production*, 40(2), 125–136. doi: 10.1007/s11250-007-9071-8.

Delsart, M., Pol, F., Dufour, B., Rose, N., & Fablet, C. (2020). Pig farming in alternative systems: strengths and challenges in terms of animal welfare, biosecurity, animal health and pork safety. *Agriculture*, 10(7), 261. doi: 10.3390/agriculture10070261.

Department of Agriculture, Forestry & Fisheries (2024). Guidelines for Urban and Peri-urban Animal Agriculture. https://old.dalrrd.gov.za/docs/AAPS/Urban_animal_Agri.pdf. Accessed: 27 February 2024.

Food and Agriculture Organization (2008). *Biosecurity for highly pathogenic avian influenza: Issues and options*. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (2009). *Farmers hand book on pig production for the small holders at village level*.

Fualefac, D. H., Raphae, K. J., Bime, M. J., Ndebi, G., Yemele, F., Zoli, P. A., Manjeli, Y., Teguia, A., & Tchoumboue, J. (2014). Socioeconomic and technical characteristics of pig farming in the urban and peri-urban zone of Dschang-West region of Cameroon. *Discourse Journal of Agriculture and Food Sciences*, 2(1), 11–20. https://www.cabdirect.org/cabdirect/abstract/20143162308.

Graefe, S., Schlecht, E., & Buerkert, A. (2008). Opportunities and challenges of urban and peri-urban agriculture in Niamey, Niger. *Outlook on Agriculture*, 37(1), 47–56. doi: 10.5367/000000008783883564.

Guendel, S., & Richards, W. (2002). *Peri-urban and urban livestock keeping in East Africa—a coping strategy for the poor*. Technical Report Natural Resources Institute. https://www.researchgate.net/publication/237588233.

Öhlund, E., Hammer, M., & Björklund, J. (2017). Managing conflicting goals in pig farming: farmers' strategies and perspectives on sustainable pig farming in Sweden. *International Journal of Agricultural Sustainability*, 15(6), 693–707. doi: 10.1080/14735903.2017.1399514.

IBM SPSS (2022). [CT738,CT763,CT761,CT762]. https://www.ibm.com/support/pages/downloading-ibm-spss-statistics-28.

Kagira, J. M., Kanyari, P. W. N., Maingi, N., Githigia, S. M., Ng'ang'a, J. C., & Karuga, J. W. (2010). Characteristics of the smallholder free-range pig production system in western Kenya. *Tropical Animal Health and Production*, 42(5), 865–873. doi: 10.1007/s11250-009-9500-y.

Kimbi, E., Lekule, F., Mlangwa, J., Mejer, H., & Thamsborg, S. (2015). Smallholder pigs production systems in Tanzania. *Journal of Agricultural Science and Technology A*, 5, 47–60. http://www.davidpublisher.com/Public/uploads/Contribute/557a54720e290.pdf.

Kouam, M. K., Jacouba, M., & Moussala, J. O. (2020). Management and biosecurity practices on pig farms in the Western Highlands of Cameroon (Central Africa). *Veterinary Medicine and Science*, 6(1), 82–91. doi: 10.1002/vms3.211.

Mabuya, B., & Scholes, M. (2020). The three little houses: A comparative study of indoor and ambient temperatures in three low-cost housing types in Gauteng and Mpumalanga, South Africa. *International Journal of Environmental Research and Public Health*, 17(10), 3524. https://www.mdpi.com/1660-4601/17/10/3524.

Madec, F., Hurnik, D., Porphyre, V., & Cardinale, E. (2010). *Good practices for biosecurity in the pig sector: Issues and options in developing and transition countries*. FAO. https://agritrop.cirad.fr/556302.

Makovska, I., Dhaka, P., Chantziaras, I., Pessoa, J., & Dewulf, J. (2023). The role of wildlife and pests in the transmission of pathogenic agents to domestic pigs: A systematic review. *Animals*, 13(11), 1830. doi: 10.3390/animals13111830.

Matabane, M. B., Nethenzheni, P., Thomas, R., Netshirovha, T. R., Norris, D., Nephawe, K. A., & Nedambale, T. L. (2015). Status of the smallholder pig farming sector in Gauteng Province of South Africa. *Applied Animal Husbandry & Rural Development*, 8(1), 19–25. https://www.cabdirect.org/cabdirect/abstract/20163008053.

Mbuthia, J. M., Rewe, T. O., & Kahi, A. K. (2015). Evaluation of pig production practices, constraints and opportunities for improvement in smallholder production systems in Kenya. *Tropical Animal Health and Production*, 47(2), 369–376. doi: 10.1007/s11250-014-0730-2.

Mekuriaw, Y., & Asmare, B. (2014). Assessment of pig production and constraints in Mecha district, Amhara region, Northwestern Ethiopia. *Advances in Agriculture*, 2014. doi: 10.1155/2014/329254.

Mngumi, J. W. (2016). *Perceptions of climate change, environmental variability and the role of agricultural adaptation strategies by small-scale farmers in Africa: The case of Mwanga district in northern Tanzania*. Doctoral dissertation University of Glasgow.

Motsa'a, J. S., Defang, H. F., Hako, T. B. A., Ojong, E. T., Mube, K. H., & Nguekem, C. L. (2021). Socioeconomic and productive characteristics of indigenous pig farming in Cameroon. *Rural Development*, 14.

Munzhelele, P. (2015). *Evaluation of the production systems and constraints of smallholder pig farming in three agro-ecological zones of Mpumalanga province, South Africa*. Phd thesis.

Munzhelele, P., Oguttu, J., Fasanmi, O. G., & Fasina, F. O. (2017). Production constraints of smallholder pig farms in agro-ecological zones of Mpumalanga, South Africa. *Tropical Animal Health and Production*, 49(1), 63–69. doi: 10.1007/s11250-016-1158-7.

Munzhelele, P., Sibeko, N. P. S., Oguttu, J. W., Mbajiorgu, C. A., & Fasina, F. O. (2024). Parasites burden in peri-urban free-roaming pigs in Gert Sibande District Municipality of Mpumalanga province, South Africa. *Journal of the South African Veterinary Association*, 95, 3–12. doi: 10.36303/JSAVA.601.

Mwasi, G. M., Jung, J. O., Mbugua, P. N., Kinama, J. M., & Okello, G. O. (2017). The contribution of urban and peri urban livestock farming in Nairobi county, Kenya. *Journal of Agriculture and Veterinary Science*, 10, 26–42.

National Planning Commission (2013). Transforming human settlement and the national space economy. In *National Development Plan – 2030: Our Future, Make it Work* (pp. 259–293). https://www.nationalplanningcommission.org.za/assets/Documents/NDP_Chapters/NDP%202030-CH8-Transforming%20human%20settlements.pdf accessed 19 March 2025.

Omondi, S. O., Oluoch-Kosura, W., & Jirström, M. (2017). The role of urban-based agriculture on food security: Kenyan case studies. *Geographical Research*, 55(2), 231–241. doi: 10.1111/1745-5871.12234.

Phiri, I. K., Ngowi, H., Afonso, S., Matenga, E., Boa, M., Mukaratirwa, S., Githigia, S., Saimo, M., Sikasunge, C., & Maingi, N. (2003). The emergence of Taenia solium cysticercosis in Eastern and Southern Africa as a serious agricultural problem and public health risk. *Acta Tropica*, 87(1), 13–23. https://www.sciencedirect.com/science/article/pii/S0001706X03000512.

Region, W., & Tracy, K. (2018). The effect of housing systems on the welfare of pigs in Santa sub-division in the North West region of Cameroon. *Journal of Environmental Issues and Agricultural Development in Countries*, 10, 24–25.

Singh, M., Pongener, N., Mollier, R., Paton, R., Yadav, R., Katiyar, R., & Mishra, V. (2023). Participatory assessment of management and biosecurity practices of smallholder pig farms in North East India. *Frontiers in Veterinary Science*, 10. doi: 10.3389/fvets.2023.1196955.

United Nations (2018). World Urbanization Prospects: The 2018 Revision. https://population.un.org/wup/publications/Files/WUP2018-KeyFacts.pdf accessed 22 January 2024.

Wati, N. K. R., Amrawaty, A. A., & Sri Lestari, V. (2022). Gender roles at pig farming. *Advances in Environmental Biol.*, 16(11), 1–5. doi: 10.22587/aeb.2022.16.11.1.

Weyer, J., Le Roux, C. A., Kajese, C., & Fernandes, L. (2020). A dog bite study in a dog rabies-affected area in South Africa. *Southern African Journal of Infectious Diseases*, 35(1). doi: 10.4102/sajid.v35i1.65.