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ORIGINAL RESEARCH

Potential for using indigenous pigs in subsistence-oriented and market-oriented small-scale farming systems of Southern Africa

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Abstract Indigenous pigs in South Africa are a source of food and economic autonomy for people in rural small-scale farming systems. The objective of the study was to assess the potential of indigenous pigs for improving communal farmer's livelihoods and to inform policy-makers about the conservation of indigenous pigs. Data were collected from 186 small-scale subsistence-oriented households and 102 small-scale market-oriented households using interviews and direct observations. Ninety-three percent of subsistence-oriented and 82 % of market-oriented households kept indigenous pigs such as Windsnyer, Kolbroek and non-descript crosses with exotic pigs mainly for selling, consumption and investment. Farmers in both production systems named diseases and parasites, followed by feed shortages, inbreeding and abortions as major constraints for pig production. Diseases and parasites were more likely to be a constraint to pig production in subsistence-oriented systems, for households where the head was not staying at home and for older farmers. Market-oriented farmers ranked productive traits such as fast growth rate, good meat quality and decent litter size as most important selection criteria for pig breeding stock, while subsistence-oriented farmers ranked good meat quality first, followed by decent growth rate and by low feed costs. We conclude that there is high potential for using indigenous pigs in subsistence-oriented production systems and for crossbreeding of indigenous pigs with imported breeds in market-oriented systems.

Keywords Pig genetic resources · Indigenous pigs · Rural development · Selection criteria

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Introduction

The socio-economic roles of livestock include savings, insurance, cyclical buffering, accumulation and socio-cultural roles related to status and obligations of their owners (Halimani et al. 2010). Although animal genetic resources are needed to enable farmers to respond to changes in the environment, markets and human preferences, they are threatened by sporadic disease outbreaks and indiscriminate crossbreeding (Halimani et al. 2010). In South Africa, for example, over 335,000 pigs were culled in 2005, following the outbreak of the classical swine fever (CSF) (World Organisation for Animal Health 2005), and there was a 95 % loss in production. Some farmers hid their pigs indoors, in forests and mountains and refused to accept compensation price that was about four times their market value. Farmers in small-scale farming systems should, therefore, be consulted to understand their production objectives and establish the selection criteria for pigs (Roessler et al. 2008).

Lemke and Valle Zárate (2008) reported that small-scale systems can be differentiated according to location, market access and production intensity. Communities that are located near urban areas are usually driven by the market demand for pork, while areas far away from the towns raise pigs for subsistence or informal markets in the community. The pig

genotype preference for farmers near urban areas is likely to differ from those of poverty-stricken rural farmers (Drucker and Anderson 2004). As such, intervention measures to promote pig production in small-scale farming systems should consider suitable genotypes that would assist different farmers to realise their production objectives. Indigenous pigs are well adapted to the backyard and scavenging production systems (Zanga et al. 2003; Chimonyo and Dzama 2007), while exotic pigs are fast growing, but do not survive harsh tropical conditions. To formulate policies that boost small-scale pig production and contribute to household food security, selection criteria of pigs by small-scale farmers should be established.

The broad objective of the study was: (1) to explore the potential for using indigenous pigs in rural development in subsistence- and market-oriented small-scale farming systems in Southern Africa in order to improve farmers' livelihoods and (2) to inform policymakers about pig restocking strategies in areas affected by CSF. The information may be useful for the restocking of indigenous pigs in areas affected by CSF in South Africa. We tested the hypothesis that the potential for using local pigs in a small-scale subsistence farming system is similar to small-scale market-oriented farming system.

Materials and methods

Study sites

The study was conducted in small-scale farming systems of Elundini (subsistence-oriented), Ntabankulu (subsistence-oriented) and Ngqushwa (market-oriented) municipalities in the Eastern Cape Province of South Africa. The sites were chosen after the CSF outbreak and policymakers needed data to restock pigs in the Eastern Cape Province. The sites were selected with participation of State Veterinary Services, University of Fort Hare, councillors, farmer representatives and government officials. Ntabankulu Municipality was the only one where pigs were not culled because the pigs tested negative against CSF. In addition, farmers in Ngqushwa Municipality are generally less poor and market-oriented when compared to the subsistence-oriented farmers in Elundini and Ntabankulu Municipalities. Communities in Ngqushwa Municipality were producing pigs for sale to the nearby King Williams (20 km) and Peddie (3 km) towns. This market-oriented pig production system was also more capital intensive and obtained more income from pigs when compared to others. Elundini and Ntabankulu Municipalities composed of rural communities that were resource-limited and raised pigs mainly for household consumption. All three municipalities are representative of most small-scale farming systems in Southern Africa where pigs form integral components of mixed crop–livestock farming systems by providing manure or cash for the purchase of inputs for crop production.

Data collection

Data were collected from August to December 2009, from the three municipalities using individual structured questionnaires, in-depths interviews with key informants and direct observations of pigs and production practices. Primary information about pig production was obtained from key informants such as extension officers, veterinary specialists and local leadership (political and customary). Secondary information was obtained from the Department of Agriculture, South Africa. Communities with many pig-owning households were identified with the assistance of the National Department of Agriculture. The households with pigs were identified with the assistance of the local leadership, and the snowballing technique was used to select participants who were willing to participate in the project. The snowballing method, however, has bias in that it may not truly represent the target population. Identifying the appropriate person to conduct the sampling, as well as locating the correct targets is time consuming and expensive. The questionnaires were administered in the vernacular Xhosa language. Key informants included farmer representatives, extension officers, animal health technicians, local leadership (political and customary) and the elderly people who were pig farmers. The key informants were interviewed to establish the pig production trends, factors affecting production levels and traits of economic importance, as a first step in designing a structured questionnaire. Wealth status was categorised during interviews with key informants and was based on number of livestock species, employment or total household income. Any household owning more than 5 heads of cattle or more than 20 heads of small stock (sheep, goats and pigs) was considered as less resource-poor, while the other category of less privileged people was considered as more resource-poor.

The number of households interviewed in Elundini, Ngqushwa and Ntabankulu was 122, 102 and 64, respectively. Aspects covered in the questionnaire consisted of household demography pig production (number born alive from the most recent litter and pre-weaning mortality) and trait preference.

Statistical analyses

The generalised linear models procedure of SAS (2003) was used to analyse for the effects of farmers' socio-economic profiles, pig production system (subsistence-oriented and market-oriented) and pig rearing practice (backyard and scavenging) on pig herd sizes, litter size at birth and pre-weaning.

Pair-wise comparisons of the least square means for litter size at birth and pre-weaning mortality were performed using the PDIFF option. The reasons for keeping pigs, causes of piglet mortality and reasons for pig breed preferences were ranked using the Kruskal–Wallis test (NPAR1WAY procedure) (SAS 2003).

Pig herd size of five and less than five were considered to be small, while herd sizes above five were regarded as large. An ordinal logistic regression (PROC LOGISTIC) was used to determine the probability of a household to sell pigs for income generation. The logit model fitted pig-rearing practice, availability of housing structures for pigs, cattle and pig herd sizes, sheep and goats flock sizes and socio-economic factors (gender, age, education, employment, wealth status, household size and whether the head of household was resident on the farm). The logit model used was:

$$\mathrm{In}[P/1-P] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_{3\ldots} + \beta_t X_t + \varepsilon$$

where P is the probability of a household to sell pigs for income generation; $[P / 1-P]$ is odds ratio, which referred to the probability of a household to sell pigs for income generation; β_0, the intercept; $\beta_1 X_1 \ldots \beta_t X_t$, regression coefficients of variables, and ε, random residual error.

When computed for each predictor ($\beta_1 \ldots \beta_t$), the odds ratio was interpreted as the proportion of households selling pigs for income generation versus those that produced for subsistence. Similar ordinal logistic regression models were used to estimate the likelihood of a household to experience parasites and/or diseases challenges using variables such as pig production system, pig-rearing practice, household size, pig housing and head of household's demographic factors such as age, education level, employment status, marital status and place of residence.

Results

Farmers' socio-economic background

There were no differences in farmers' demographics across all three municipalities. Overall, about half of the interviewees were men, and the other, women (Table 1), and the mean household size was 5.2±4.63 (mean ± standard error). Most of the interviewees did not have a formal employment and survived on farming or social grants. There were more respondents with basic education (grades 1–7) than secondary or tertiary education. Most of the heads of households (defined as the person who was taking care of the day-to-day management of the household) were resident on the farms. Many interviewees were less poor with significant more less-poor households in Elundini ($P<0.05$). Most interviewees indicated that the youths were interested in pig rearing although some reported that they did not want to be associated with pigs because they considered them as dirty animals.

Pig production levels

Many women over 60 years were actively involved in pig rearing, particularly in Ntabankulu, while men, boys and girls helped in the absence of women. Activities carried out by these women included feeding of pigs, penning, facilitated mating, health management, purchasing breeding stock and selling pigs. Men were involved in slaughtering and construction of housing for the pigs. In most interviewed households, particularly in Elundini, women owned the pigs (Table 1). Most interviewees kept indigenous pigs and 12 % kept non-descript crossbreds (have unknown proportion of mixed blood for Large White, Landrace, Kolbroek or Windsnyer). In the market-oriented production system, 15 % of the households kept Large White and Landrace pigs. Most of the interviewees kept their pigs under backyard rearing system (Table 1).

Interviewees in market-oriented production systems kept significantly more pigs than in subsistence-oriented systems (Table 2). Less-poor households had higher mean pig herd sizes of 8.1±2.39 compared to 6.3±2.34 for resource-poor households ($P<0.05$). Market-oriented production system generally had a higher ($P<0.05$) number of breeding female pigs than the subsistence-oriented farmers. Gender of head of household, marital status, occupation, religion, production system and farmer's place of residence had no effect on the number of breeding females. Litter size was higher ($P<0.05$) for the market-oriented production system than the subsistence-oriented production system (Table 2). Pigs for employed respondents had a significantly large litter size (10.4±1.77) than their non-employed counterparts (8.5±1.83). Less poor households had significantly higher litter size (10.3±1.78) than resource-poor households (9.1±1.76). Gender of head of household, religion and production system had no effect on litter size.

Pre-weaning mortality was higher ($P<0.05$) for the subsistence-oriented Ntabankulu Municipality than the other two municipalities (Table 2). Elderly people (>45 years) were associated with high pre-weaning mortality (1.6±0.80) compared to the youths (1.6±1.00). Gender of head of household, marital status, occupation, religion, production system, wealthy status, farmer's place of residence and education level did not affect pre-weaning mortality.

Reasons for keeping pigs

Reasons for keeping pigs varied with the production system (Table 3). Raising household income was the most important reason for keeping pigs in market-oriented production systems, while consumption was ranked high in subsistence-

Table 1 Socio-economic characteristics, challenges and perceptions of respondents (percentage) on pig production issues in market-oriented and subsistence-oriented farming systems

Socio-economic characteristic	Elundini (n=122)	Ngqushwa (n=102)	Ntabankulu (n=64)
Male headed households	52	47	55
Married respondents	67	63	73
Women owning pigs	81	60	69
Unemployed respondents	79	77	80
Respondents with basic education (grades 1–7)	50	55	47
Respondents that were Christians	88	84	70
Respondents living on the farm	70	85	65
Less-poor respondents[a]	69	75	84
Female pig keepers over 60 years of age	51	37	37
Respondents keeping indigenous pigs	89	82	97
Respondents applying backyard rearing system	73	89	36
Respondents whose rearing system varied seasonally	18	34	16
Youths reported as interested in pig rearing	66	89	79
Farmers experiencing feed shortage	75	92	79
Respondents housing their pigs at night	68	90	32
Respondents who confirmed climate change	62	93	95
Respondents experiencing gastro-intestinal parasites	28	44	23
Respondents who borrow breeding boars	65	66	26
Respondents who support conservation of local pigs	86	88	92

[a]A household owning more than 5 heads of cattle or more than 20 heads of small stock (sheep, goats and pigs); otherwise, the household was regarded as resource-poor

oriented production system. Socio-cultural uses were ranked higher in subsistence-oriented than in market-oriented production systems. Farmers in both production systems considered pigs as important for provision of fat for use as cooking oil, softening leather ropes or mixing with other concoctions to chase away evil spirits. Farmers in all production systems mentioned that the indigenous pigs are an integral part of the crop–livestock system because of their ability to utilise crop residues and the provision of manure to fertilise garden crops.

The majority of farmers in Elundini (81 %), Ntabankulu (65 %) and Ngqushwa (96 %) were selling pigs in the community. Ngqushwa Municipality is the only one where farmers were also selling their pigs to formal market such as butcheries, abattoirs and supermarkets. The market values of a breeding sow in Elundini, Ngqushwa and Ntabankulu Municipalities were USD105.00, USD158.00 and USD46.00, respectively, (exchange rate 1USD = R7). Farmers were also selling piglets to raise income in Elundini (USD7.50), Ngqushwa (USD14.30) and Ntabankulu (USD8.60). Generally, prices for sows and piglets were higher in market-oriented Ngqushwa Municipality when compared to the subsistence-oriented municipalities. The probabilities of a household to sell pigs for income generation were highest for housed pigs followed by young head of household, backyard rearing system, small cattle herd size, small sheep flock size and the unemployed (Table 4). The probability of selling pigs for income generation was high for housed pigs than those that were not housed (odds ratio 7.524). Younger people (<30 years old) were likely to sell their pigs than the elderly. Households practising backyard rearing system were also likely to sell pigs for income generation than those using the scavenging system.

Pig production practices

Despite the culling that took place in many communities, many respondents (64 %) purchased replacement breeding stock from other farmers, while others selected within herd. However, most of the interviewees (66 %) borrowed boars, and they would give a piglet when their sow had farrowed. For those with boars, 80 % reported that one boar was

Table 2 Household pig production levels (mean ± standard error) in subsistence-oriented and market-oriented small-scale farming systems

Production parameter	Elundini (subsistence-oriented)	Ngqushwa (market-oriented)	Ntabankulu (subsistence-oriented)
Total herd size	5.5±2.33 a	8.2±2.39 b	7.9±2.59 ab
Breeding females	1.2±0.83 a	2.0±0.85 ab	2.0±0.92 b
Litter size	8.4±1.73 a	10.5±1.79 b	10.3±1.99 ab
Pre-weaning mortality	0.9±0.84 a	1.7±0.86 b	2.3±1.04 c

Values with different letters differ (P<0.05)

Table 3 Uses of pigs in small-scale farming systems as ranked by subsistence-oriented and market-oriented respondents

Reason	Rank (mean rank)[a]		
	Subsistence-oriented (n=186)	Market-oriented (n=102)	Sig
Selling for income generation	2 (1.62)	1 (1.27)	*
Subsistence	1 (1.30)	2 (1.77)	*
Savings and investment	4 (2.95)	3 (2.80)	NS
Manure	6 (3.36)	4 (3.74)	NS
Provision of Fat	5 (3.27)	5 (3.76)	*
Socio-cultural	3 (2.00)	7 (4.50)	*
Family pride/status	7 (3.38)	6 (3.92)	NS

Sig significance level, *NS* not significantly different

*P<0.05); significant difference

[a] The lower the rank of the reason, the greater the importance

serving less than five sows since they were struggling to secure breeding females after the classical swine fever outbreak. Methods used to reduce inbreeding were separation of boars and sows (25 %), early culling of the boar (9 %), borrowing a boar (16 %), castration (19 %) and exchange unrelated boars permanently (9 %). Weaning period ranged from 3 to 7 months. Gilts reached puberty after about 8 months and were farrowed once per year. No differences were detected between the production systems.

Constraints to pig production

Respondents in the market-oriented Ngqushwa Municipality ranked reduced mature size over generations as the major problem associated with inbreeding, while the subsistence-oriented Ntabankulu Municipality ranked declining litter size first (Table 5). There were few cases of dystocia (3.2 %) reported across all production systems. In order of importance, crushing by older pigs, cold stress, dystocia, cannibalism, diseases and predation by dogs contributed to piglet mortality. Most interviewees in Elundini and Ngqushwa municipalities penned their pigs at night. The majority of farmers across all the production systems (94 %) did not keep records.

Eighty-two percent of the interviewees across production systems experienced feed shortage and they preferred with a high foraging ability. No official culling took place in Ntabankulu Municipality, while 97 % and 93 % of the respondents in Elundini and Ngqushwa Municipalities, respectively, reported that their pigs were culled due to the CSF outbreak. Approximately 22 % of farmers reported that they hid the piglets. Most interviewees (81 %) acknowledged that the climate has changed to hot and dry weather conditions. Climate change has affected cropping (83 %), availability of foraging material (16 %) and water (17 %) and has contributed to mortality due to starvation and heat stress (14 %). About 52 % of the farmers across the production systems had no means of adapting to climate change. Almost all interviewees felt that the indigenous pigs are tolerant to heat and should be used in restocking pigs in small-scale farming systems.

The probability of a household experiencing disease or parasite challenges were highest for production system, followed by place of residence of the head of household, education level, age of head of household and size of household (Table 6). Pigs of farmers in subsistence-oriented production system were more likely to be infested by parasites and diseases than those of farmers in market-oriented one (odds ratio=3.026). The odds ratio of 2.611 showed that heads of households, who were staying away from the farm, were twice likely to experience the pig parasites and diseases challenges than those staying at home. Households headed by old people were more likely to be affected by parasites and diseases than those led by young people (odds ratio=2.242).

Table 4 Odds ratio estimates, lower and upper confidence interval of a household selling pigs for income generation

Pig herd size	Odds ratio	Lower CI	Upper CI
Pig housing (pigs not housed vs pigs housed)	7.524	2.112	26.809
Age of the head of household (old vs young)	2.224	0.599	8.257
Pig-rearing system (free range vs backyard)	2.164	0.966	4.850
Cattle herd size (large vs small)	1.869	0.755	4.627
Sheep flock size (large vs small)	1.681	0.576	4.909
Employment (unemployed vs employed)	1.541	0.598	3.972
Marital status (not married vs married)	1.174	0.774	1.780
Education (uneducated vs educated)	1.026	0.453	2.321
Goats flock size (large vs small)	0.873	0.397	1.920
Household size (large vs small)	0.767	0.373	1.576
Residence of household head (at the farm vs away)	0.750	0.373	1.511
Wealth status (resource-rich vs resource-poor)	0.261	0.090	0.754

The first underlined category in parentheses was used as the base level (set to 1)

CI confidence interval

Table 5 Challenges associated with inbreeding as ranked by respondents in different small-scale farming systems

Problem	Elundini (subsistence-oriented)	Ngqushwa (market-oriented)	Ntabankulu (subsistence-oriented)	Sig
Reduced mature size over generations	2 (1.62)	1 (1.52)	3 (1.67)	NS
Declining litter size	4 (1.90)	4 (2.18)	1 (1.21)	*
Weak piglets	3 (1.66)	2 (1.63)	2 (1.27)	NS
Piglets born dead	1 (1.50)	3 (2.00)	4 (2.00)	NS

NS no significant difference amongst farming systems

*$P \leq 0.01$; significant difference amongst farming systems

Attributes selected for breeding pigs

Subsistence-oriented farmers mainly selected pig breeding stock for meat quality and growth rate. Ntabankulu farmers considered large litter size as more important, while their counterparts in Elundini considered low feed costs. Market-oriented farmers selected for growth rate, meat quality and large litter size (Table 7). Across all the production systems, 86 % of the respondents preferred the indigenous pig breed over the imported ones because of its meat tenderness (34 %), fatness (30 %), taste (89 %), colour (12 %) and juiciness (18 %). Body conformation and temperament were lowly ranked by all municipalities (Table 7).

Discussion

The observation that the majority of the farmers in both production systems had their pigs culled as a result of CSF meant that their source of livelihood was compromised. Farmers hid their pigs from culling or re-started piggery projects soon after culling, indicating the importance of pigs in rural livelihoods. Indigenous pigs can forage and survive on fibrous diets commonly common in small-scale farming systems (Lemke et al. 2006; Chimonyo et al. 2010). Farmers keep pigs in traditional scavenging systems as a means of risk management in terms of feed availability. Feed shortages were the major limiting factor for increasing the small-scale pig herd size, as reported in many countries (Mashatise et al. 2005; Ajala et al. 2007; Lemke et al. 2007). The change of pig-rearing system from scavenging to backyard during the rainy season concurs with what was reported by Chiduwa et al. (2008) in Zimbabwe. This is done so that the pigs do not damage crops which are also a source of livelihood for farmers in mixed crop–livestock production systems. The South African government is advocating for the confinement of pigs as a way to contain the spread of CSF. It was, however, strange that pigs kept in the backyard-rearing system were likely to have high disease incidences than free-ranging pigs. This observation might be related to the poor type of housing for the pigs.

The finding that pig production was mainly the duty of women concurs with other studies (Ajala et al. 2007; Lemke et al. 2007; Chiduwa et al. 2008). Promotion of pig production by women is a developmental tool in small-scale farming systems. The higher pre-weaning mortality for pigs kept by farmers over 60 years than for pigs kept by young farmers (<30 years) suggests that younger farmers could have improved husbandry skills. Young farmers can more easily bear the risk of accepting new innovations aimed at improving pig production than older farmers (Ajala et al. 2007). The involvement of youths in pig production reduces unemployment and the problems associated with it.

Most small-scale farmers lack resources to adequately support pig production and, hence, have to cope with poor housing, abortion, high pre-weaning mortality, inbreeding problems and low productivity. The rare outbreak of parasites and diseases was influenced by the level of education, age, place of residence of the head of household and production system. The high odds ratio for disease and parasites prevalence in subsistence-oriented production system suggests that pig farmers in these areas experience high pre-weaning mortality, which might indicate lack of resources to deal with these challenges. Farmers using crossbreeds (indigenous × exotic) are the ones likely to experience high mortality. Diseases cause abortion and reduction of farrowing rates, litter size at

Table 6 Odds ratio estimates, lower and upper confidence interval of a household experiencing disease and parasite challenges

Disease and parasites challenge	Odds ratio	Lower CI	Upper CI
Production system (market-oriented vs subsistence-oriented)	3.026	1.593	5.747
Residence of household head (at the farm vs away)	2.611	1.426	4.780
Education (educated vs uneducated)	2.428	1.301	4.528
Pig-rearing system (backyard vs free range)	0.599	0.440	1.537
Age of head of household (young vs old)	2.249	0.317	1.131
Household size (large vs small)	1.279	0.761	2.149
Marital (married vs not married)	0.948	0.734	1.224
Employment status (unemployed vs employed)	0.709	0.370	1.358
Pig housing (pigs housed vs pigs not housed)	0.617	0.322	1.184

The first underlined category in parentheses was used as the base level (set to 1)

Table 7 Ranks of attributes used for selecting pig breeding stock in consumption-oriented and market-oriented farming systems

Attribute	Rank (mean rank)[a]			
	Elundini (subsistence-oriented) (n=122)	Ngqushwa (market-oriented) (n=102)	Ntabankulu (subsistence-oriented) (n=64)	Sig
Growth rate	2 (2.58)	1 (2.23)	2 (2.29)	NS
Litter size	4 (3.72)	3 (3.19)	3 (4.43)	*
Meat quality	1 (2.16)	2 (2.67)	1 (2.27)	*
Low feed cost	3 (3.57)	5 (4.66)	4 (4.36)	*
Parasite/disease resistance	5 (4.21)	4 (4.21)	6 (4.95)	*
Foraging ability	7 (5.14)	9 (6.12)	5 (4.83)	**
Mothering ability	6 (4.96)	6 (5.26)	9 (6.50)	**
Temperament	10 (6.22)	8 (5.95)	8 (6.34)	NS
Heat tolerance	8 (5.57)	7 (5.53)	7 (5.66)	NS
Body conformation	9 (6.09)	10 (6.23)	10 (7.25)	*

Sig significance level, *NS* not significantly different

*$P \leq 0.05$; mean ranks of attributes in different municipalities are significantly different

**$P \leq 0.01$; mean ranks of attributes in different municipalities are significantly different

[a]The lower the rank of the attribute, the greater is its importance

birth and weaning, birth weight and viability of piglets, sow's milk yield and litter weight gain. Farmers in market-oriented production system were supported to cope with rare disease outbreaks by veterinary experts from the National Department of Agriculture.

Pigs compete with human needs for maize grain. Inadequate feed supply prolongs the weaning-to-oestrus interval, hence the observed once a year farrowing (Lemke et al. 2006). Feed shortage and the CSF outbreak could explain the observed low herd sizes since farmers could not afford to sustain large pig herd sizes. Farmers maintained small herd sizes by selling excess piglets or consuming the mature pigs. Farmers with pig housing were seven times likely to own and sell a large pig herd than those without pig housing. Housed pigs may be easy to supplement to attain good growth and reproductive performance, although it was not tested in this study. Pig housing protects them from harsh weather conditions such as heat and cold stress which minimises pre-weaning mortalities. Poor and muddy housing also predisposes the piglets to diseases and increases deaths due to cold stress. Thus, indigenous pigs still need good husbandry practices despite being hardy and resistant to many environmental challenges.

Many farmers in the market-oriented production system tried to control mating by separating females and males, castration, early culling and exchange of boars. Despite taking all these measures, inbreeding was still a challenge. The challenge became greater with the outbreak of CSF, which made it difficult to secure replacement boars. The subsistence-oriented farmers, practising scavenging rearing system, could not control mating in winter except in summer when they switch to backyard production. The borrowing and exchange of boars is too localised, and at the end, all the pigs in the community are likely to be related. Reluctance to sell the best breeding stock amongst farmers in both production systems might result in the use of foundation stock with poor breeding qualities. Consequently, farmers would start to experience pigs with stunted growth, small litter size, weak piglets or born dead. It is recommended that farmers buy breeding boars from distant communities and keep them for short periods to minimise chances of inbreeding. The low numbers of sows in many households might be because farmers consider the keeping of boars economically not viable. Relying on hired boars for breeding sows affects breeding plans when the boar is not available and this contributed to poor farrowing index (Wabacha et al. 2004; Huynh et al. 2007). Indiscriminate crossbreeding of indigenous pigs with imported pigs should be discouraged because it dilutes the ability of indigenous pigs to resist disease challenges, hence threatening the genetic resource. In addition, indigenous pigs survive well under resource-limited low-input systems. The government is recommended to promote the conservation of indigenous pigs that will be bred and sold to rural farmers for sustainable rural development.

Farmers in market-oriented production systems ranked "selling to raise income" and consumption as the major functions of pigs. These households also valued pigs more as a form of savings and investment than for their socio-cultural uses and hence, mainly selected pigs for growth rate and litter size. This might also explain the larger litter size in market-oriented than in subsistence-oriented production systems. Farmers in market-oriented production systems have better support by extension services and initiatives to restock after the outbreak of CSF. Pigs are better managed when they make a significant contribution to production and income than when saving is the major function.

Farmers in both production systems preferred crossbred pigs. Indiscriminate crossbreeding, replacement of indigenous pigs with imported pigs and lack of clearly defined

policies on conservation of indigenous genotypes threaten their continued existence (Halimani et al. 2010) and chance to contribute to the development of future breeds. Farmers also select pigs for mothering ability as another productive trait linked to ensuring large litter size at weaning. The market prices of the pig breeding females were highest in Ngqushwa Municipality (USD158.00) because farmers are market-oriented. However, it is not clear why all farmers lowly ranked body conformation, yet it is important when selecting for meat yield. Meat from pigs raised under scavenging rearing system is lean and tasty (Lemke and Valle Zárate 2008). Meat from indigenous pigs tends to be discriminated against in the commercial market because of their dark colour and short carcasses (Chimonyo et al. 2010).

Subsistence-oriented farmers select pigs for adaptive traits such as foraging ability because it limits feed costs, while this trait was not very important for the market-oriented farmers who could afford commercial supplement feed. The finding that the majority of farmers acknowledge climate change impacts might imply the need to identify breeds that can better survive the harsh climatic conditions. Many farmers across both production systems face constraints to adapt to climate change, suggesting the need for policymakers in Southern Africa to develop coping strategies. Overall, the promotion of indigenous pigs that are adapted to the harsh environmental conditions prevailing in small-scale farming systems is likely to contribute to rural development and enhance food security in Southern Africa.

Conclusions

Indigenous pigs are mainly used and selected for income generation in the market-oriented production system, while they are used for consumption in the subsistence-oriented production system. This is important for poverty alleviation and enhancing food security in Southern Africa. The findings suggest that indigenous pigs have the potential to produce good litter size and to attain lower pre-weaning mortalities under market-oriented production system than subsistence-oriented production system. Farmers in small-scale farming systems select their pig breeding stock based on adaptive and productive traits such as foraging ability (utilise fibrous plant material), heat tolerance, diseases and parasites resistance, large litter size at birth, fast growth and desirable meat quality. The findings could be useful in designing an appropriate restocking programme that considers the use of the much preferred and adapted indigenous pig genotypes.

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