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Some insights into the phenotypic and genetic diversity of indigenous pigs in southern Africa

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Abstract

Indigenous pigs in southern Africa are mainly owned by economically vulnerable groups in marginal areas where they are used as a source food, income and security. A study was carried out to achieve three objectives: to describe pig production systems, get a phenotypic description of the pigs and to characterize them genetically. A survey of 199 farmers in three districts in South Africa, (Vhembe, OR Tambo and Alfred Nzo) and one district in Zimbabwe (Chirumhnazu) was carried out. Additional farmers in Malawi (Dedza, Mchinji and Salima) and Zimbabwe (Mutoko) were sampled in order to meet the other two objectives. Most of the pigs (69.7%) were owned by women, with men owning 20.5% and children the remainder. Production of the pigs was constrained by several factors including disease, inadequate feeds, poor housing and lack of knowledge. The majority of the pigs were small and black with characteristics that are probably suited for thermoregulation in arid environments. The third objective was achieved through genotyping 111 pigs using 22 microsatellites. Preliminary results indicate very little differences across populations with an overall inbreeding coefficient of the subpopulation relative to the total population (F_{ST}) of 0.071. The results indicate that the indigenous pigs in southern Africa are relatively homogenous.

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Introduction

Indigenous pigs in southern Africa are kept in resource-poor households by vulnerable groups in marginal areas (Chikwanha *et al*., 2007; Chiduwa *et al.*, 2008). Their value lies in various attributes including adaptability and tolerance to those diseases and parasites that are endemic in their areas of production (Lekule & Kyvsgaard, 2003; Zanga *et al.*, 2003; Halimani *et al.*, 2010). Furthermore, they are better able to utilize fibrous feeds compared to exotics (Kangengoni *et al.*, 2002; 2004) and are more suited for outdoor production in hot environments due to a higher thermotolerance (Styger, 2002; Wilson, 2009). They are, however, underutilized in the mainstream economies of southern Africa. Several factors may contribute to this including traditional biases in meat and carcass grading systems, prejudice against local pigs, lack of markets and market penetration, and relatively little research that aims at improving the indigenous pigs (Halimani *et al*., 2010). Several articles have been published on indigenous pig production systems (Mashatise *et al*., 2005; Chikwanha *et al*., 2007; Chiduwa *et al.*, 2008; Halimani *et al.*, 2008) but these have been of limited scope and confined samples within districts. Other studies focused on disease and parasite tolerance (Haresnape *et al.*, 1987; Zanga *et al.*, 2003; Bastos *et al.*, 2004; Penrith *et al.*, 2004; Marufu *et al.*, 2008), nutrition (Chikwanha *et al*., 2007), genetics (Chimonyo & Dzama, 2007) and diversity (Ojeda *et al.*, 2008; Ramírez *et al.*, 2009; Swart *et al.*, 2010). There are, however, several gaps in the literature on the genetic diversity, geographical distribution, physical attributes and production environments of indigenous pigs. This study reports on results of a survey conducted across international boundaries, aimed at combining data on production systems, physical attributes and genetic diversity in order to build a

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fairly broad picture of indigenous pig production in southern Africa. The data was analysed in the context of looking for opportunities for the conservation of indigenous pigs in southern Africa.

Materials and Methods

A survey was carried out in parts of Zimbabwe and South Africa, namely the Chirumhanzu district in Zimbabwe, and Vhembe, OR Tambo and Alfred Nzo districts in South Africa. A structured questionnaire (Halimani *et al.*, 2012) was used targeting 78 farmers in Zimbabwe, 99 in Vhembe district and 22 in OR Tambo and Alfred Nzo districts. Information was collected on pig ownership, number of pigs per household, the importance of the pigs in the household farming system and constraints faced by farmers. Information solicited from farmers and the reasons why that information was sought are summarised in Halimani *et al.* (2012). Physical characteristics of the pigs at each household were recorded during the surveys by observing the pigs in the pens. Additional pigs in households, which were not part of the questionnaire survey, were also observed in Mutoko (10 pigs) and Malawi (45 pigs). Chi square analyses and exact tests using SAS (2004) were carried out to determine association of household attributes with various responses. Furthermore, blood samples were collected on FTA Micro Cards (Whatman International Ltd) or into vacutainer tube. DNA was extracted from the blood samples at the University of Western Cape molecular biology laboratory, using the standard Phenol-chloroform method. This was followed by polymerase chain reaction (PCR) amplification using 22 microsatellites (S0155; SW395; S0226; SW72; SW902; S0301; S0001; IGF1; SW22; S0025; SW175; S0086; SW539; SW920; S0230; S0090; SW210; SW2515; SW936; SO296; SW1023; SW787). The PCR amplification protocol involved a single reaction of 9 µL (5 ng/µL), where 4 µL was QIAGEN master mix (QIAGEN). The physical conditions included a 15 second denaturation step at 95 °C, followed by 25 cycles of 30 seconds at 94 °C, 90s at specific annealing temperatures depending on locus ranging from 55 to 62 °C and 1 minute at 72 °C. The cycles were followed by 30 seconds at 60 °C and held at 4 °C (http://www.genome.iastate.edu/pigs/resources/fprimerset1-2.html). Genetic diversity and population differentiation were carried out using FSTAT software (Version 2.9.3, http://www2.unil.ch/popgen/softwares/fstat.htm). Details on the procedures are available in Halimani (2012).

Results and Discussion

Most of the pigs (69.7%) were owned by women, while 20.5% and the remainder 9.8% were owned by men and children, respectively. More women were found in the low income groups compared to men. Farmers owned various livestock which influenced the importance of the pig production enterprise within the farming system. Irrespective of income, farmers kept relatively small herds (less than seven animals) with piglets, weaners and sows dominating. Very few farmers owned boars. Various workers have reported that farmers keep relatively small herds in order to match production to the available resources (Mashatise *et al*., 2005; Chikwanha *et al*., 2007; Chiduwa *et al*., 2008). Related to this, most of the farmers (68%) kept, and preferred to keep, indigenous pigs, while a relatively small proportion (5%) kept exotic pigs. The remainder kept crossbred animals. This is also related to the desire to match production to resources, since indigenous pigs are smaller and are better able to forage and supplement their diets (Lekule & Kyvsgaard, 2003). Farmers cited several reasons for keeping pigs including home consumption and sales. The multiple roles of indigenous pigs have been recognised and are the major reasons why indigenous pigs are maintained in smallholder production systems (Halimani *et al*., 2010). The free range production system coupled with the small numbers of boars place the pigs at risk of inbreeding.

Farmers faced various constraints which were ranked as follows: inadequate feeds, inadequate housing, diseases and parasites, lack of access to markets, lack of husbandry or management skills and institutional support. Most of these constraints have been recognised by other workers (Chikwanha *et al*., 2007; Chiduwa *et al.*, 2008). These needs have to be addressed if indigenous pigs can be popularised and marketed. Inadequacy of feed controls the production environment since farmers are forced to keep small indigenous pigs in small herds. From a breed conservation perspective this leads to the risk of inbreeding, deliberate selection of smaller animals and the maintenance of the breed only in impoverished households.

Most of the indigenous pigs kept were small and black with medium length hair. The ear size was small to medium with an almost equal distribution of erect, lateral and droopy orientations. Their features include a small body, which leads to a favourable volume to surface ratio, straight hair, which allows air

circulation close to the skin, a black colour and lateral or erect ears. These features may be implicated in heat management in hot environments (Madzimure *et al*., 2012).

There were high heterozygosity levels in the pig populations in the different regions and countries (0.61 - 0.75). These figures are comparable with those for Mexican hairless pigs and Chinese pigs. They are, however, higher than those for commercial breeds which range from 0.35 to 0.60 (Lemus-Flores *et al*., 2001). This may be due to the absence of improvement programmes among these populations and the possible existence of several genetic lineages (Ramírez *et al*., 2009). Wright's (Wright, 1951; Weir & Cockerham, 1984) 'fixation indices' refer to the inbreeding coefficient of an individual relative to the subpopulation (F_{IS}), relative to the total population (F_{IT}) and of the subpopulation relative to the total population (F_{ST}). Results from this study indicate that these indices were low to moderate, i.e. for $F_{IS,}$ F_{IT} and F_{ST} values were 0.05 - 0.081, 0.071 - 0.092 and 0.049 - 0.078, respectively. The between-population-component of total genetic diversity was very low with very little differentiation among populations (overall F_{ST} value was 0.071; Nei's distances below 0.20). Nei's (Nei, 1972) distances were correlated to estimate geographic distances ($R^2 = 0.384$; $P < 0.05$). The results indicate that the pigs sampled in this study have very little population sub-structuring. An overall F_{ST} value of 0.071 means that 92.9% of genetic variation was due to genetic variation within each population and 7.1 was between populations. Swart *et al*. (2010) reported relatively little differentiation among field populations of pigs in Southern Africa (12.3% between Mozambican and Namibian pigs). Such findings indicate that the sampled pigs are strains within a breed that are spread across southern Africa. This reduces the need for conserving the breed, allowing the pooling of resources to manage the indigenous pigs of Southern Africa.

Conclusions

Indigenous pigs in Southern Africa are widely distributed in resource-poor smallholder production systems with little access to livestock markets. Further, there was more variation within pig populations than between them. This improves chances of breed conservation and utilisation since the pigs can be considered being not under threat.

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