Chapter

Tracing the Domestic Pigs in Africa

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Abstract

Pigs are vital to the economy and critical in meeting the ever increasing demand for livestock and livestock products in most parts of the world. Pig is one of the oldest domesticated animals, though their ancestory is still shrouded in controversy due to lack of sufficient archaeological and genetic information. However, most of the breeds are thought to have descended from the Eurasian Wild Boar (*Sus scrofa*). This chapter will therefore look at the African pig under the following headings: Introduction, origin of pigs – genetic and historical/archaeological evidences, pig breeds in Africa, economic importance of pig production in Africa, marketing of pigs in Africa, herd health management of pigs in Africa, and challenges affecting pig production in Africa.

Keywords: pigs, *Sus scrofa*, Eurasian Wild Boar, Africa, economy, breeds

1. Introduction

1.1 Origin of pigs: genetic and historical/archaeological evidences of African domestic pigs

Pig is one of the oldest domesticated animals and majority of the breeds are known to have descended from the Eurasian Wild Boar (*Sus scrofa*). Archaeological evidence from the Middle East indicates that pigs were domesticated as early as 9000 years ago when most livestock were utilized by nomadic peoples, and swine are more indicative of a settled farming community [1]. The wild boar was recorded to be widespread in Eurasia and occurs in Northwest Africa; at least 16 different subspecies has been proposed to exist [2]. However, it is not yet established whether modern domestic pigs which displays significant morphological differences compared with their wild ancestor have a single or multiple origin since Darwin [3] identified two primary grouping of the domestic pigs belonging to the European (*Sus scrofa*) and the Asian (*Sus indicus*) groups, respectively. Although *Sus scrofa* was assumed to have originated from the European wild boar, the wild ancestor of the *Sus indicus* was unknown as the two were considered as distinct species by Darwin based on their profound phenotypic differences.

The origins of African domestic pig breeds are obscured and highly controversial due to lack of sufficient archaeological and genetic evidence to establish sound hypotheses about how, when and where they were founded. Although *Sus scrofa,* the ancestor to African domestic pigs is known as a native to North Africa, its range

extends along the Atlantic coast as far as the Rio de Oro [4–6], with the Maghreb race sometimes known as *Sus scrofa barbarous,* and the Saharan race known as *Sus scrofa sahariensis* [7]. A later classification however joined the three into a single race *Sus scrofa algirn* [8]. Despite the recording of *Sus scrofa* as the ancestor of African domestic pigs by some researchers, there are still some that argued that there is no positive evidence of the domestication of pig in Africa [7]. The African breed's genetic diversity and the relationship between the domestic pigs and their ancestor *Sus scrofa* has not been elucidated or studied extensively like that of the European and Far Eastern pig breeds [9]. Therefore, in an attempt to provide the missing links to our knowledge, Ramirez and his colleagues [10] carried out the first genetic survey of a number of pig breeds distributed in Western (Nigeria and Benin) and Eastern (Kenya and Zimbabwe) sub-Saharan Africa but did not find any close relationship between the Near Eastern wild boars and African pigs similar to the findings of the study on Near Eastern and European *S. scrofa* populations [11, 12]. Thus, this finding was considered as preliminary since the number of West African pigs sampled in this study was quite low, and region where we might logically expect to find a Near Eastern or North African signature, such as the Ethiopia–Sudan borderlands or Senegambia were not sampled [6]. However, several studies have either found abundant mitochondrial cytochrome b haplotype being shared by African and European wild boars and pigs, or Near Eastern mitochondrial haplotypes in a couple of *S. scrofa* museum samples from Egypt and Sudan but not with Near Eastern wild boars [10, 13]. There is therefore the need to perform a comprehensive survey of African pig breeds in order to assess the frequency and geographical distribution of Near Eastern mitochondrial haplotypes in Africa [6].

The wild pigs of Africa are the warthog, *Plincochoerus aethiopicus,* the giant forest hog, *Hylochoerus ineinertzhageni* and the bush-pig, *Potamochoerus pntcus*, were found to have made no genetic contribution through breeding to the characteristics of the domestic pigs in the continent. [14]. Resolution of the genetic make-up of the African pig breeds has also revealed a substantial difference between west and east of the continent. The West Africa pigs shared some alleles that are abundant in European breeds, while east and southern African breeds harbour Far Eastern alleles at very high frequencies [10]. Additionally, genetic estimates of the prevalence of the mitochondrial cytochrome b E1 haplogroup in some West African states revealed their abundance [10]. However, this information did not allow appropriate discrimination of the West African autochthonous breeds that descended from domestication in North Africa, from those introduced by the early European colonist of the fifteenth to nineteenth centuries.

The history of pigs in sub-Saharan Africa has been blurred by the importation of very large numbers of European pig breeds into all parts of the continent through a number of ways ranging from undocumented subsistence strategies or colonial agricultural development projects [6]. Thus, the genetic heritage of today's African pig populations is extremely mixed. Secondly, the history and distribution of pigs in Africa have been substantially affected by the growth and domination of many parts of Africa by Islam. This has led to the disappearance of pigs from a wide swathe of Africa in historic times [6].

2. Pig breeds in Africa

The domestic pig, based on historical records and scientific evidence, is thought to have originated from the Eurasian wild boar (*Sus scrofa*). This information has been used by several scientists to validate the ancestry of many of the common pig breeds in circulation in Europe and Asia [5]. However, there is evidence to suggest

that the Asian domestic pigs have a separate ancestry distinct from the European ancestor based on analyses of microsatellites, as well as established genetic variation between the two lineages of domestic pigs as they do not share mitochondrial alleles [15]. The history of the local African pig has been debated in the past [4] but the African pig is thought to have been domesticated following the introduction of Asian and/or European pigs through commercial trade routes [15]. This was further substantiated with increasing genetic studies on the local populations of African pig breeds, with study by Ramirez and colleagues [10] showing that North to West African pig breeds have significant European ancestry which may not be unrelated with the Portuguese exploration in the 15th century. There is also report that contemporary Eastern African pig breeds ancestry could have either been by direct introgression with Far Eastern breeds or through a European intermediary since the earlier British breeds were shown to have carried some Eastern alleles in the past [10]. The African Union InterAfrican Bureau for Animal Resources [16] has summarized the description of the local African pigs as small, dark coloured animals with small ears, short forehead, straight tail and an elongated snout. The body is often narrow, carried on relatively long legs. Coat colour is variable and sometimes covered with long, coarse hairs and a distinct mane along the spine. They may vary in size but rarely weigh above 60 kg as adults. Indigenous pigs are considered to be hardy, and well adapted to harsh environmental conditions [17].

In West Africa, the indigenous pigs are known by several names such as the West African dwarf pig (Nigeria), Ashanti dwarf pig (Ghana), or the bush pig (Togo). The Ashanti Black Forest Dwarf pig of Ghana, commonly called the Ashanti Dwarf Pig for instance, has been shown to have both a European and Asian ancestry, with the pigs differing from the north to the south of the country [18]. Phenotypically, these pigs have been described as having a concave head profile, black coat colour, erect ears that sometimes project backwards and a short cylindrical snout. They are hardy, able to survive under poor management, mostly scavenging for their food and can digest high fibrous matter; they are well adapted to resist heat stroke as well as other harsh environmental conditions and are considered to be less susceptible to many local diseases and parasites; they also have good mothering ability. Average body weight of adult pig is 60 kg, bearing 5–7 piglets [18]. The Nigerian indigenous pig (NIP) is described in a similar manner to the Ghanaian local pig [19, 20]. Eastern African and Southern Africa indigenous pigs have also been described [21, 22].

The Local African Pig Breed of Burkina Faso. Copied from: au-ibar.org

The Local African Pig Breed of Burkina Faso. Copied from: au-ibar.org

Nigerian Local Pig breed. (Pictures courtesy of Adedeji JA).

Nigerian Local Pig breed on a free range Management system. (Pictures courtesy of Adedeji JA).

The introduction of pigs into Southern Africa is thought to have taken place later than for other regions of the African continent, and this might have occurred through the processes of barter, warfare and migration as there is little historical

information on the Southern Africa indigenous pig populations [22]. There are two recognized indigenous pig breed populations in Southern Africa namely: "Kolbroek" and "Windsnyer". There is however a third group of local pigs referred to as the South African hard-footed pigs which are free ranging scavengers and converters of unutilized household and farm waste [22].

The South African "Kolbroek" breed. Copied from: Farmersweekly.co.za. Photo: *Wessel Pistorius.*

The South African "Windsyner" Pig Breed: Copied from: livestock-oftheworld.com

While the Eastern African indigenous pigs are sturdy, dark to light coloured skin, black or white long feet, long narrow snout and a well-developed mane, the Kolbroek pigs are short, with prickled ears, short snout and a squashed face. They are dark black or brown in colour, often striped at birth; docile nature with high disease resistance, and thrives well on a high fibre diet. Windsnyer pigs on the other hand are smaller with bristles that form a distinct mane. The coat colour varies from black, reddish-brown, black and white to spotted. They are narrow-bodied, long-nosed and razor-backed, and are able to survive periods of food scarcity. Other pig breeds described by Swart are the Namibian and the Mozambican pig breeds. The Namibian indigenous pigs are found in the northern communal areas of Namibia, and their origin is unsure but they are thought to be brought from areas around the Mediterranean Sea. They are relatively long, lean-bodied pigs with long snout, with coat colour ranging from mottled brown to black and white. They are well adapted

to harsh environments with low maintenance requirements, fertile, and are excellent lard producers [22] The Botswanan indigenous pig breed is found mostly in the southern part of the country called the Tswana. The pig is predominantly black in colour, and well adapted for the climatic conditions of Botswana [17].

Indigenous pig breeds are unique to the geographic locations where they are found and possess genetic characteristics which may provide future breeds with production traits that are advantageous for survival [23]. These qualities include their adaptation to harsh environments, resistance to disease and adaptation to harsh production system in developing countries [24]. These advantages are quickly being lost due to the inability to compete with the fast-growing commercial exotic breeds and the resultant indiscriminate cross-breeding of the local with the exotic species which has consequently narrowed the gene pool of the local breeds [25]. Poverty, lack of information on the attributes of local pigs and ill-defined government policies and programmes have been adduced as some of the reasons why local pig breeds are being lost very rapidly [26]. There is therefore the severe danger of losing the local pig biodiversity because of the race to satisfy high production capacity of pigs' i.e. fast growth and large litter size [23]. Thus, a number of researchers have reported a steady waning of the indigenous pig population in Africa, with some recommending the conservation of the germplasm of valuable genetic resource [24, 27–29]. In Nigerian, the local pigs (**Figure 2b**) have been replaced with exotic breeds such as Large White, Landrace, Hampshire and Duroc because of the afore-mentioned advantages [24]. Similarly, the commercial pig industry in Southern Africa has been taken over by exotic pig breeds which were imported to enhance the industry and meet the demand of the market system [22]. Predominant exotic pig breeds in South Africa include the South African Landrace, the Large White, the Duroc and the Pietrain [22]. The Eastern African commercial pig industry as seen in Ugandan, has also been replaced with exotic pig breeds such as Camborough, Landrace and Large White along with their crosses [30]. However, many small producers acknowledge the value of local pigs and they have resolved to conserve them [31]. Thus, it is necessary to work on pig conservation and the development of the family production system that will conserve the genetic potential of African local or indigenous breeds [28, 32].

The indigenous pigs are reservoirs of genes and sources of heterosis, but these variable and valuable traits suited for our particular ecological zone are constantly being threatened by genetic erosion, leading to a progressive loss of genetic diversity [33]. These phenomena are actually related to the implementation of indiscriminate and unsustainable crossbreeding programs which influence the structure and dynamics of the pig populations in Africa. It is therefore imperative to draw attention to the disappearance of the indigenous African pig breeds [6, 16, 25]. However, in view of the diverse roles indigenous pig plays, it entails that there is need for an increased knowledge of the indigenous pig, their characterization and conservation to support sustainable agricultural development and maintain local breeds of pigs which have variable traits suited to a particular ecological zone [34].

3. Economic importance of pig production in Africa

In most African countries, the agricultural sector still provides a relatively large share of GDP [35]. Livestock production can contribute to poverty reduction in various ways including increase in food supply, source of income and a means for capital accumulation, employment opportunities and supply inputs and services for crop production. Livestock also represents an important factor for social integration [36]. Pig production has the potential of improving the real per capita income of

Sub-Saharan African reported as $688 in 2010 compared $1717 of the rest of the world. Over the past 30 years, GDP growth per capita in SSA has an average of 0.16 percent per year [35]. However, pig production is an important means of livelihood in many parts of Africa, particularly in rural communities [37–39]. It is increasingly perceived as a source of income generation and poverty reduction.

Despite the decline in the use of indigenous breeds and the shift towards more improved, exotic breeds in most part of Africa including South Africa over the years, indigenous pigs in African remain a source of food and income for people farming in rural areas and subsistence-orientated production systems [37, 40, 41]. These indigenous pigs and their crosses are noted for their high potential for subsistence-oriented production systems [37]. Thus, many small-scale rural farmers in various parts of South Africa still keep indigenous pigs [37, 42, 43] probably due to their ability to remain productive even when living in poor sanitary conditions and fed low quality feed. This low input requirement is helpful in low-income rural communities [44].

In 1998, Nigeria was estimated to have 4.86 million pigs, followed by Uganda (1.55 million), South Africa (1.54 million), Cameroon (1.35 million), and the Democratic Republic of Congo (1 million) as the top five pig populations in Africa [45]. This has grown in the last two decades, as presently Nigeria is estimated to have over 7.5 million pigs, Malawi 6.3 million, Uganda 2.7 million, Angola 2.6 million, Burkina Faso 2.5 million, Madagascar 1.7 million and Mozambique 1.6 [46]. Presently, Africa is estimated to have over 40 million pigs [46]. In many African countries, particularly tropic regions, most of the pigs is kept by smallholders in rural area (51). Uganda, for instance has 2.3 million pigs being kept by one million households for consumption and translates into cash in times of emergencies [47]. Pig enterprise has been reported to be a profitable enterprise that should be encouraged and embarked upon [48]. More often than not, pig farming is combined with crop farming. A pig possesses a large caecum, and its manure is rich in nutrients which make it good source of organic fertilizers for crops and can also be recycled into livestock feeds. Besides having main production systems like extensive, semi-intensive and intensive system; there are also subsistence-oriented households and market-oriented households which look to pig production for different reasons [37]. Pigs also can contribute positively to the empowerment of women and enhance their equal participation in local markets [49].

In recent times, commercial pig production under intensive system of management is becoming more popular because of the favourable return on investments. Owing to increasing human population and demand of meat source, pork production has scaled up with a developing pig value chain which gradually established over time. This chain includes several stakeholders like input suppliers, middlemen, traders, transporters and butchers who play vital roles in the economy of communities, regions and countries where pig production is thriving. Farmers are also able to enter at different phases of the production chain as breeders (selling piglets), pig fatteners (selling live or slaughtered pigs), or both. The feed supply input is exemplified in local feed mill production for pig feed as seen in Uganda [49].

Pigs are largely slaughtered for home consumption, during funerals and cultural ceremonies [50] Pig production has been reported to be a dependable source of income for livelihood activities like school fees, income and consumption in Uganda [51, 52] medical bills, fertilizer purchase, and debt recovery. In Congo pig farming was for cash [53], in Ghana it was for consumption, savings, wealth/status, breeding and manure [54], while in South Africa pigs were seen as a substitute for savings [55]. In Cameroun and Congo, it was considered as an emergency fund [44, 53], and sales were done during festivities, and when demand was high. In Nigeria it was kept for income and consumption [56]. In Namibia, and Kenya pig

keeping is for income and consumption [57] while it was for cash in Botswana [58] and South Africa [59].

The impact of diseases in pigs can also result in huge economic consequences for farmers' livelihoods and income generation both at household level, community level and regional level. The impact of diseases results in losses of income to the farmers, and possible closure of market. No country is yet to export pork meat in Africa, however reasonable trade is known to occur within regions. Such examples can be seen between Nigeria and Benin in West Africa [39] and between Uganda and Kenya in East Africa [60].

4. Marketing of pigs in Africa

Pig production system across Africa is dominated by small-holder pig owners mostly in rural areas with poor farm infrastructure and limited biosecurity [61–63]. The production system in Africa is faced by many constraints, with marketing being a limiting factor to the expansion of pig populations in Africa. Pig marketing in Africa is mainly dominated by sales of live pigs through auctions by farmer, traders or middlemen [40, 56]. Sales of these live pigs involved movement to various destination evading ante-mortem inspections and congregation at the point of sale, thus leading to spread of infectious diseases [40]. These small holders pig farmers do not have access to high value markets and the market they patronize are generally exploitative, collusive and economically inefficient [64]. High value markets are only limited to big commercial pig farms that supplies pork to supermarkets and companies [61], while the main channels of marketing pigs in many African countries are through auctions at live pig markets, slaughtering facilities and direct sales to individuals [56, 65, 66]. These trade/marketing practices also have huge concomitant influence on the breeding programs as better price value are gotten for improved exotic breed in comparison to indigenous breeds of pigs.

Another marketing-associated limiting factor to small holder's pig farmers is having good value for their animals, because pigs are considered more or less as a single-product animal in most pig producing areas in Africa unlike cattle, sheep and goats [64]. This is because pork is the only end product of the production system, as other by-products like lard, hair etc. are not utilized.

Live pig markets are generally categorized into three: primary/collection markets; secondary/regrouping markets and terminal market, with many actors (farmers, traders, assemblers and brokers) within each market performing different functions or roles along the marketing chain [56]. The practices in some countries where pigs sold passes through two or more middlemen before eventually reaching the market or consumer makes such pig to become highly expensive to the consumer [56, 67]. While some farmers may sell directly to other farmers without using the middlemen, others farmers in several African countries sells their pigs in the local community or neighbourhood at low prices [17, 50, 53, 58, 59, 65, 67, 68], as most of the famers especially in South Africa could not gain entrée into sustainable markets due to lack of information, knowledge and skills on the selling price of pig [65, 68]. In some African countries the middle men purchase the pigs from farmers at poor prices and sell to traders; at pig slaughter houses or pork serving centres' in order to escape taxes at the slaughter slab [51], while in Botswana, the main pig market for pig farmers are the local meat processors and butcheries [69, 70] and the common marketing chain involves "farm–abattoir–butchery or processing plants and the end products were distributed to shopping malls [61]. In Nigeria, sales are either in cash or credit depending on relationship between the buyers and traders, as well as on size, health status, body score, season and festivals at the time of sales [56].

It has been reported that a solid relationship existed between auctions and prevailing market price of pigs as high pig populations at auctions show that the market prices are good [65]. Others have however observed that pig and pork were generally more expensive in dry season (September to April) when the Fulani herdsmen migrate to the south (causing a temporal shortage of beef) and also due to Christmas and Easter festivities in December and April respectively [56]. Therefore, in order to improve price and access to market, there is need to investing in market infrastructure, organizing pig farmers into cooperative groups, and develop other products from pigs as part of value chain addition. Furthermore, government policies aimed at improving prices of pigs/pork and access to high value market for small holder's farmers particularly farmers rearing indigenous pigs should be put in place.

4.1 Marketing constraints

Pig wholesaling and retailing is assumed to be oligopolistic leading to higher marketing margin for the traders through incorporation of gain market power and control of market price paid by consumers since only a few handles the bulk of the trade and majority of the farmers are also traders operating in the same market with majority of them controlling both production and marketing decisions [56].

Secondly, standardization/grading of animals and adequate price information are absent in the markets and creates problem/difficult for the traders in many African countries [43, 52, 56, 59, 65, 67, 68, 71]. In addition, there are lack of price harmonization among the farmers since no templates exists to standardize transactions even on live pig-weight estimate [68], which in turn forced pig farmers to consent to any amount middle men offered them [67]. This has resulted in farmers having an irregular income because they regularly sell their pigs at poor prices as observed in Kenya, Tanzania and South Africa [41, 65, 67, 71, 72].

Thirdly, marketing of pigs and their products in many African countries is poor and not organized and is generally accompanied by seasonal variations in market price due to poor demand [38, 40, 41, 51, 52, 56, 59, 61, 65, 67, 68, 70, 73–79].

Fourthly, marketing in Africa countries is also dominated by inadequate equipment/infrastructure, slaughter facility, lack of refrigeration/storage facilities and poor hygiene [52, 56, 61, 65, 67, 70, 71, 79, 80]. There was limited processing ability due to poor electricity supply [51, 52, 74, 81, 82]. Thus, to avoid condemnation at abattoirs [40] and spoilage, farmers are forced to sell their pigs at informal markets and at poor prices. This has been reported in South Africa [40, 43, 68, 73], Kenya [67] and Tanzania [41]. Consequently, majority of the farmers in South Africa reported that they sold to any willing buyer due to lack of stable market [73].

Fifthly, few wholesalers are usually involved in the transaction compared to retailers [56] because of insufficient funds and credit facilities as reported in Kenya [38] and Nigeria [56, 78, 83]. Moreover, lack of funds affected pig production and marketing especially due to high cost of transportation faced by the traders in Botswana and Nigeria [56, 79, 84]. In some instances, the problem is exaggerated due to increase in the price of petroleum and spare parts of vehicles [56, 70, 71, 85]. This is because majority of the traders in most African countries including Uganda do not own vehicles for transportation and thus engage the services of other transporters [66]. Hence both live pigs and pig carcasses are transported in trucks, buses, roof of saloon cars, bicycles and motorbikes openly while pigs from neighbouring villages are trekked directly to the markets in Nigeria (motorbike transportation of pigs in Quan-Pan LGA of Plateau state, Nigeria - **Figure 2a**) [56, 86] and Kenya [74]. The method of transporting pig/pig products can spread diseases including African swine fever and foot and mouth disease etc. which comes with severe economic consequences [82].

5. Herd health management of pigs in Africa

Herd Health Management of pigs just like in other livestock involves all the farm practices that promotes health, improve productivity and prevent diseases in animals for the benefit of all stakeholders in the industry, while at the same time not sacrificing animal welfare, food safety, public health and environmental sustainability [87]. Traditionally, the essence of herd health is to control or eliminate diseases and management inefficiencies that may impact on welfare or limit swine productivity. This is achieved by ensuring comprehensive husbandry management systems that includes breeding, biosecurity and environmental management, nutrition management, parasite control, vaccination, adequate risk monitoring and assessment in conjunction with best farming practices in a practical and economically feasible way [88]. Health management of Swine in Africa is dependent on the type of husbandry or production system being employed by the farmer. Three major management systems are obtainable in most developing countries of Africa, and they include:

5.1 Free-range (scavenging) system

The free-range (scavenging) system which is the oldest and traditional method of rearing pigs in most parts of the world is mostly obtained in rural areas where resources (feeds and capital) are limited but with ample land resources necessary for wandering animals (**Figure 1a**). It involves households keeping a small number (1–3) of pigs which can roam about and scavenge for food and water, with occasional provision of kitchen wastes, and farm by-products. Pigs are rarely sheltered and there is no investment on feed or veterinary services [74]. The unrestricted roaming often leads to indiscriminate mating, with high probability of inbreeding leading to poor quality offspring. Local pig breeds are suitable for this system because they have high resistance to diseases and can manage with low-quality feed therefore, disease control in this system is quite minimal since little or no investment and management are needed [89]. In several African countries where the free-range traditional system of pig production has been characterized, its hallmark includes high mortality rate due to diseases, minimal health care, slow growth rate due to poor feed conversion, low off take, low reproductive rates, lack of supplementary feeding, and lack of proper housing [90, 91].

Figure 1.
(a) Free-ranging village pig, Langtang, Nigeria. (b) Semi-intensively kept pigs, Shendam, Nigeria. (c) Intensive piglets in a farrowing pen in Jos-south, Nigeria (d) Backyard pig farm, Wukari, Nigeria. (Pictures courtesy of Adedeji JA).

Figure 2.
(a) Transportation of pigs Quan-Pan LGA. (b) Local Nigerian Pig breed (Courtesy, Adedeji AJ).

5.2 Semi-intensive system

The semi-intensive system involves the restriction of pigs to a limited space (**Figure 1b** and **1d**), with the provision of feed (kitchen wastes and agricultural by-products), water and veterinary services. Periodically, the pigs are allowed into a larger area to exercise, graze, and wallow, such that some classes of pigs are kept outside the pig shelters, e.g. boars and sows stay within a perimeter fence where water, feeds and shade are provided [70].

5.3 Intensive system

The intensive system of farming is characterised by complete housing of pigs and provision of complete diets (**Figure 1c**). In this system, pigs are shifted from one pen to another according to the production stage, until they reach market weight [70]. This management system is practised in large-scale commercial systems that are characterized by improved breeds, use of commercial concentrates for feeding and proper housing with sophisticated equipment and biosafety measures [33]. In certain parts of Africa especially the urban areas where land resources are minimal due to explosion of human population and urbanization, pig farmers tend to adopt the intensive and semi-intensive systems of production [91].

5.4 Diseases affecting pigs

The most prevalent and endemic disease responsible for outbreaks in many pig producing areas of Africa is the African swine fever, a viral disease that spreads rapidly and is associated with high morbidity and mortality [92, 93]. Other known infectious diseases that have been recorded includes, but not limited to swine erysipelas, brucellosis, exudative dermatitis (greasy pig), respiratory diseases, swine dysentery, mastitis, and porcine parvovirus. Parasitic diseases in the form of Helminthosis (Strongylid parasites, *Strongyloides ransomi, Ascaris suum*, *Metastrongylus* sp., *Trichuris suis, Taenia solium*), protozoa (coccidiosis and trypanosomiasis), and ectoparasitism [94] also erodes the economic gains due to reduced weight gain and litter size, poor growth rates, condemnation of carcass at slaughter and sometimes death [95].

Diseases and poor herd-health management practices are the major challenges to efficient management and profitable swine production in developing countries of the world [96]. In terms of disease control and herd health management in most

pig producing areas of Africa, government and private veterinarians are usually available to provide disease diagnosis and treatment services. However, the level of acceptance of such services from farmers varies especially among smallholder farmers. In preventing swine diseases, having a herd health plan usually help to minimize disease incidence, thus most farmers depend on the provision of adequate housing, good husbandry and nutrition, hygiene, and ventilation [97].

Vaccination is a major focus of disease prevention and herd-health management in pig production. Vaccines in use in a few African countries against production limiting diseases of pigs includes but not limited to Erysipelas, *Escherichia coli*, *Leptospira* and Parvovirus. In Africa where production is concentrated on the extensive and semi-intensive systems with smaller pig herds, dealing with major disease issues is not taken seriously as is being done in the developed countries with larger intensive/commercial pig production system. Therefore, vaccination which forms an important part of the overall health management of the intensive pig production is usually overlooked in small holding and extensive populations. As a result of the above, the Food and Agriculture Organization (FAO) and some experts are advocating for a community-specific farm-health plan with messages on the importance of vaccination, antibiotic abuse and biosecurity, which targets the small holder group using state veterinarians and animal health technicians [98, 99].

6. Challenges affecting pig production

While pig farmers in many African countries are scaling up their businesses from backyard to commercial enterprises due to increased population growth and demand for complementary source of animal protein, many are confronted with a number of challenges ranging from high feed costs that are prohibiting their progress, transboundary diseases and inadequate extension and veterinary service, poor breeding stock, unorganized marketing and inadequate slaughter facilities. Another challenge is the religious sentiments in some part of Africa towards pigs and pork products [38, 67, 74]. Despite these challenges pig farming and pork are gradually gaining acceptance in Africa. However, for production to be raised, these challenges need to be addressed individually at farm level and collectively by stakeholders through collaborative efforts.

6.1 Disease

Efficient and profitable pig production has been on the decline in Africa irrespective of the benefits derived from pig farming due to disease as observed in Nigeria [29, 78], Senegal [100], Kenya [67, 74] Congo [53], Southern Africa [37, 101], Botswana [61], Uganda [51, 52, 102], Tanzania [103], and Cameroon [80]. Livestock diseases forms one of the key threats to the livestock industry and specifically pig farming since diseases that affect livestock reduce productivity [104]. Livestock diseases including pig disease represent a major constraint to profitable production and have devastating impacts upon the industry leading to losses in hundreds of millions of dollars every year in Sub-Saharan Africa [105, 106]. Important pig diseases especially in Nigeria include: African swine fever, foot-and-mouth disease, brucellosis, Trypanosomosis, babesiosis, eperythrozoonosis, helminthosis, coccidiosis and other parasitoses (reviewed in [106]). These diseases impact negatively on production by affecting feed conversion efficiency, reproduction and growth rates as well as causing piglet and adult mortalities [106]. There is also the risk of zoonosis associated with some of the pig diseases. In general, a disease control strategy that can provide for the sustainability and expansion of the pig production capacity [106] is necessary in Africa.

6.2 High pig mortality

High piglet and pig mortality rates has been reported in many African countries [32, 37, 38, 53, 58, 68, 69, 73, 74, 78, 83, 91, 103, 107–109]. These piglet mortalities affects both exotic and indigenous breeds, and were largely attributed to low birth weights and diseases such as septicaemia and colisepticaemia [101, 106] or high pre-weaning mortalities have been associated with crushing and chilling which are indication of inadequate husbandry management practices when farrowing pen with heating facilities are not provided [61, 69]. In addition, starvation, agalactiae and stress have also been reported to cause pre-weaning mortality [101]. Therefore, strategies that can provide adequate neonatal health and prevention of infertility and abortions in herds are paramount and appropriate initiative for growth of the pig population [106].

6.3 High cost of vaccines and drugs and poor accessibility to veterinary and extension services

Most animal production activities in Africa are located in rural areas or remote areas that are inaccessible to proper veterinary services, while those that are accessible grapple with high cost of drugs and veterinary services that may be prohibitive. Thus, the farmers are forced to resort to easily available quacks that can wreak havoc on their animals due to wrong diagnosis and the prescriptions of wrong drug for treating diseases, or the use of expired vaccines, fake and sub-standard drugs [105, 110]. In addition, poor veterinary services were also reported among small scale farmers due to lack of skilled veterinarians or inadequate Vet staff. Sometimes the access by farmers to veterinarians is often limited by poor infrastructure including road/transport system as observed in many African countries including Nigeria, Kenya, Uganda, Tanzania, Cameroon, and Ethiopia [38, 67, 71, 74, 80, 83, 102, 103, 107, 111].

Major production constraints including high cost of drugs, veterinary services and labour encountered by pig producers in many Africa including Nigeria, Kenya, Senegal, Congo, South Africa, Uganda and Angola have been reported [29, 32, 38, 53, 54, 73, 83, 86, 100]. Similarly, limited vaccination and biosecurity or public health preventive measures with little or no treatments of sick pigs have been reported in some African countries among small-scale pig farmers [17, 38, 40–42, 68, 71, 75, 76, 80, 111].

The extension system and services in Africa is also poor and ineffective and extension networks are weak. Farmers did not know veterinarians existed as observed in Tanzania [103], Ethiopia [111], Kenya [38, 67, 71], Botswana [61, 70], South Africa [17, 42, 59] and Nigeria [112]. In addition, extension staff are not sufficiently trained and equipped to offer excellent service to pig farmers as observed in Botswana [61, 70] and South Africa [40]. Poor relationship between small scale farmers and animal health technicians have also been reported in many African countries [53, 67, 73, 102], thus depriving them of the opportunities to access health services for their animals. There is therefore the need for governments of most African countries to standardize and subsidize veterinary services to farmers [105].

6.4 Poor level of education of farmers

Some farmers lacked knowledge of veterinary services, as they did not know they could contact veterinarians to offer veterinary services for their animals in South Africa [40, 52, 68, 73] and Kenya [67]. While some of the farmers were misinformed over the effectiveness of some veterinary treatments and vaccines

in Congo [53] and South Africa [65]. However, others believe that indigenous pigs can't fall sick especially with intestinal parasites as reported in South Africa [17] and Kenya [38], and thus do no need treatment. Similarly, farmers lacked knowledge on pig diseases and their identification in Kenya [67, 74].

The lack of basic knowledge on pig management practices was observed among famers, thus such farmers resort to traditional pig farming system which are archaic and unproductive. Pigs were seen under poor management system, with some either roaming freely, tethered or kept in poor and improper housing most of the year, while some are penned during the rainy season and sheltered only in the night. This was done in order to keep the cost of input of production low as observed in many African countries [29, 37, 38, 68, 73, 81, 102, 111, 113–116]. Free range pigs also serve as sources of neighbour's conflicts due to their destructive behaviour on farmlands [78], which in extreme cases leads to the shootings or salt poisoning of pigs [67]. Tether wounds were commonly observed on the neck and leg of pigs which is a welfare worry as farmers lacked the knowledge to tie proper knots and do not regularly rotate tethers to different sites on the pig's body as reported in Kenya [38].

6.5 Lack of infrastructure

The farmers are faced by high cost of production inputs including building materials, hence farmers use poor building material for pig housing as observed in Senegal [100], Nigeria [29, 83, 116], Uganda [52, 102], South Africa [68, 73], Cameroon [80], Botswana [61], Kenya [38] and Ghana [117]. High cost of pigs and piglets was also common challenges among small scale farmers as reported in Nigeria [78, 86], hence shortage of piglets has been observed in some African countries like Kenya [67]. Due to the poor or lack of infrastructure, small scale farmers allow their pigs to roam, thus confound deworming of pigs and also expose pigs to increased risk of diseases and infections, theft and pilferage [37, 40, 41, 73, 74, 102, 113].

6.6 High cost of feeds

Good and nutritious feeds are essential for growth, body maintenance and productivity, but animal feeds which are nutritive and essential for productivity are not readily available and where they are, they are not easily affordable for an average farmer [105]. In pig production, feeds which are mostly made up of maize and soya beans account for approximately 88% of the cost of production [69]. However, most African countries and the farmers do not produce enough of these cereals to meet the demands of the pig farmers. Thus, feed manufacturing companies depends more on imported raw materials to meet their customer's needs [61], thus making their finished product expensive, and since farmers are into animal production for profit, the high cost of feeds make production unsustainable.

High feed cost is observed or reported in many African countries [31, 51, 52, 65, 68, 71, 73, 75, 103, 107, 108, 113]. Unbalanced diets were also given to pigs in many African countries which adds to their slow growth and causes a reduced pig performances [29, 40, 41, 51, 53, 54, 61, 70, 71, 73, 77–81, 83, 111, 117].

Feeding of swill/kitchen wastes/leftovers to pigs by small- holder farmers is commonly reported across Africa as a substitute to commercial feeds and to reduce the cost of production [42, 53, 57, 68, 80, 111]. Inadequate feeding was commonly practiced in dry season, in Kenya [38] and South Africa [17, 73]. Swill generally consists of restaurant waste and kitchen scraps [43, 44, 59, 75]. However, feeding such feed is associated with poor growth and depressed economic gain [43], and

predispose pigs to infection and diseases [43]. The feeding of swill has been associated with disease occurrence especially, FMD and ASF [102].

6.7 Breeding stock of inferior quality

Some African pig industry like Uganda largely depend on indigenous breeds of pigs [52] however the challenges across Africa include lack of good quality breeding stock [38, 40, 51, 68, 71, 74–76, 81, 82, 86].

Farmers reported poor reproductive performance across various regions of Africa [38, 58, 68, 107]. This is confounded by the fact that most of the farmers do not have boars and are thus forced to source for boars in neighbouring towns [37, 38, 40, 41, 51, 86, 118] or buy auctioned boars to service their sows which promotes the spread of diseases [43, 51, 68, 73, 107] and promotes Inbreeding. Inbreeding causes depression, and a weakening of genetic pools [40, 73], loss in heterozygosity and increases homozygosity which results in increased lethal genes that increase embryonic death, mummified foetuses etc. [61]. Lending of boars also causes break in biosecurity measures and promotes the spread of parasites and diseases [41, 73, 99, 107, 108]. Moreover, breeding is not controlled as the farmers had no set purposes; it is just carried out randomly [117].

6.8 Lack of capital

The farmers also found it difficult to access credit facility or institutional/government loans as reported in Nigeria [79, 112], Uganda [52], Kenya [67], Botswana [61] and South Africa [73]. Hence most of the farms could not enlarge but existed under small scale [67, 86]. Water and electricity are also lacking and limited in some locations as seen in Uganda [52], Botswana [70] and Nigeria [79] as such small-holders do not have the finance to provide their own sources of water and electricity. Lack of Land and sufficient space for pig farming was observed by some studies in Nigeria [29, 79], Kenya [67] Uganda [52], Botswana [61, 70], and South Africa [40, 75].

6.9 Social and religious beliefs

Social and religious beliefs are among the constraints to pig production in Africa due to the fact that pigs are not readily accepted by most communities because of cultural, spiritual problems and religious reasons which renders it a taboo for pork to be eaten by some individuals [29, 38, 67, 78, 100, 111].

7. Recommendation

1. Inbreeding should be decreased and controlled breeding should be encouraged [42].

2. Biosafety should be encouraged to control diseases such as African swine fever, FMD, Porcine cysticercosis etc. and farmers should be trained on diseases control [17].

3. Feeding practices should be improved [81].

4. Management system, and housing should be upgraded and pig confinement be emphasized. Government can design model pig houses and make them available to farmers [67, 81].

5. Record keeping should be emphasized among farmers [54] and producers, middlemen, traders and slaughter men for pork safety and traceability in Africa [38, 67].

6. Encouraging farmers to form cooperatives/pig farmers association in order to obtain capital/loans.

7. Small scale farmers and extension workers should be trained on husbandry practices [68, 102].

8. Government should provide physical infrastructure in the market and abattoirs and provide slaughter slabs with shades and portable water and adequate drainage facilities [79] and traders should provide cold stores in the market for meat storage [56].

9. Government should give farmers credit facilities in order to enable them expand their pig farms [119–124].

8. Limitation

Our study had the limitations of not being a structured research but most of the materials and relevant records were sourced from the following data base; Pubmed, Google scholar, Google, Ajol, Hindawi, text books, internet explorer, and NCDI Data base. Hence there might be some literature that we may not have been able to access or some records that have not been published.

Conflict of interest

The authors declare no conflict of interest.

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References

[1] Bokonyi S. History of domestic mammals in Central and Eastern Europe 1974

[2] Ruvinsky A, Rothschild MF. Systematics and evolution of the pig In: Genetics of the Pig, M. Rothschild and A. Ruvinksy (Eds.). CABI Press. 1998: 1-16. https://lib.dr.iastate.edu/ans_pubs/413

[3] Darwin C. The variation of plants and animals under domestication. Popular edition ed. by Francis Darwin. London, Murray. I: xv. 1868.

[4] Blench RM. A history of pigs in Africa. The origins and development of African Livestock: Archaeology, genetics, linguistics, and ethnography. , UCL Press, London 2000:355-67

[5] Giuffra EJ, Kijas JM, Amarger V, Carlborg Ö, Jeon JT, Andersson L. The origin of the domestic pig: independent domestication and subsequent introgression. Genetics. 2000; 154(4):1785-1791.

[6] Amills M, Ramírez O, Galman-Omitogun O, Clop A. Domestic pigs in Africa. African Archaeological Review. 2012; 30(1):73-82. DOI 10.1007/s10437-012-9111-2

[7] Epstein H. The origin of the domestic animals of Africa. New York Africana Publishing Corporation; 1971. https://hdl.handle.net/10568/70619

[8] Groves C. 1981. Ancestors for the pigs: taxonomy and phylogeny of the genus' Sus'. Technical Bulletin RSPS, Canberra, Department of Prehistory (3).

[9] Amills, M., Clop, A., Ramírez, O., & Pérez-Enciso, M. Origin and genetic diversity of pig breeds. In Encyclopedia of life sciences. Chichester: Wiley. (2010).

[10] Ramirez O, Ojeda A, Tomas A, Gallardo D, Huang LS, Folch JM, Clop A, Sánchez A, Badaoui B, Hanotte O, Galman-Omitogun O. Integrating Y-chromosome, mitochondrial, and autosomal data to analyze the origin of pig breeds. Molecular Biology and Evolution. 2009; Sep 1; 26(9):2061-2072. https://doi.org/10.1093/molbev/msp118

[11] Larson G, Dobney K, Albarella U, Fang M, Matisoo-Smith E, Robins J, Lowden S, Finlayson H, Brand T, Willerslev E, Rowley-Conwy P. Worldwide phylogeography of wild boar reveals multiple centres of pig domestication. Science. 2005; 307(5715):1618-21. DOI: 10.1126/science.1106927

[12] Manunza A, Zidi A, Yeghoyan S, Balteanu VA, Carsai TC, Scherbakov O, Ramírez O, Eghbalsaied S, Castello A, Mercade A, Amills M. A high throughput genotyping approach reveals distinctive autosomal genetic signatures for European and Near Eastern wild boar. PloS one. 2013; 8(2):e55891. https://doi.org/10.1371/journal.pone.0055891

[13] Larson G, Albarella U, Dobney K, Rowley-Conwy P, Schibler J, Tresset A, Vigne JD, Edwards CJ, Schlumbaum A, Dinu A, Bălăçsescu A. Ancient DNA, pig domestication, and the spread of the Neolithic into Europe. Proceedings of the National Academy of Sciences. 2007; 104(39):15276-15281.

[14] Haltenorth, T. and Diller, H. 1980. A guide to the mammals of Africa, including Madagascar. London: Collins. 1980

[15] Amills M. Biodiversity and origin of pig breeds. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Animal Science and Biotechnologies. 2011; 68(1-2).

ISSN 1843-5262; Electronic ISSN 1843-536X

[16] AU-IBAR. Local African Pig. African Union Inter-African Bureau for Animal Resources 2015. Available at http://www.au-ibar.org/2012-10-01-13-08-42/features/series/know-youranimalsseries/local-african-pig

[17] Thutwa K, Chabo R, Nsoso SJ, Mareko M, Kgwatalala PM, Owusu-Sekyere E. Indigenous Tswana pig production characteristics and management practices in southern districts of Botswana. Tropical Animal Health and Production. 2020; 52(2):517-24. https://doi.org/10.1007/s11250-019-02037-3

[18] Osei-Amponsah R, Skinner BM, Adjei DO, Bauer J, Larson G, Affara NA, Sargent CA. Origin and phylogenetic status of the local Ashanti Dwarf pig (ADP) of Ghana based on genetic analysis. BMC genomics. 2017 Dec 1; 18(1):193. DOIhttps://doi.org/10.1186/s12864-017-3536-6

[19] Oluwole OO, Omitogun OG. Cytogenetic characterization of Nigerian indigenous pig. African Journal of Biotechnology. 2009; 8(18). Available online at http://www.academicjournals.org/AJB ISSN 1684-5315 Academic Journals

[20] Adedeji TA. Qualitative and quantitative characterization of body morphometric of indigenous pigs in the humid environment of Nigeria. Continental Journal of Animal and Veterinary Research. 2012; 4:11-6. doi:10.5707/cjavres.2012.4.1.11.16

[21] Penrith ML, Thomson GR, Bastos AD, Phiri OC, Lubisi BA, Du Plessis EC, Macome F, Pinto F, Botha B, Esterhuysen J. An investigation into natural resistance to African swine fever in domestic pigs from an endemic area in southern Africa. Rev Sci Tech. 2004 Dec 1; 23(3):965-77 DOI:10.20506/RST.23.3.1533

[22] Swart H. *Microsatellite-based characterization of southern African domestic pig (Sus scrofa domestica) breeds* (Doctoral dissertation, University of Limpopo (Turfloop Campus). 2010; 1-16

[23] Hlongwane NL, Hadebe K, Soma P, Dzomba EF, Muchadeyi FC. Genome wide assessment of genetic variation and population distinctiveness of the pig family in South Africa. Frontiers in Genetics. 2020; 7; 11:344. https://doi.org/10.3389/fgene.2020.00344

[24] Barnes AR, Fleischer JE. Growth rate and carcass characteristics of indigenous (Ashanti Dwarf) pig. Ghana journal of agricultural science. 1998; 31(2):217-21. **DOI:** 10.4314/gjas.v31i2.1935

[25] Ndofor-Foleng HM, Iloghalu OG, Onodugo MO, Ezekwe AG. Genetic diversity between large white and Nigerian indigenous breed of swine using polyacrylamide gel electrophoresis (PAGE). Agro-Science. 2014; 13(3):30-6. **DOI:** 10.4314/as.v13i3.5

[26] Halimani TE, Muchadeyi FC, Chimonyo M, Dzama K. Pig genetic resource conservation: The Southern African perspective. Ecological Economics. 2010 Mar 15; 69(5):944-51. https://doi.org/10.1016/j.ecolecon.2010.01.005

[27] Pathiraja N, Oyedipe EO. Indigenous pig of Nigeria. Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales. 1990; 7:63-70. DOI: https://doi.org/10.1017/S1014233900003023

[28] Adeola AC, Omitogun OG. Characterization of indigenous pigs in Southwestern Nigeria using blood protein polymorphisms. Animal Genetic

Resources/Resources génétiques animales/Recursos genéticos animales. 2012 Dec; 51:125-30. IN Animal Genetic Resources, 2012, 51, iii. Food and Agriculture Organization of the United Nations, 2012 doi: 10.1017/S2078633612000550

[29] Nwachukwu CU, Udegbunam C. Rural pig production and pork consumption in Imo State, Nigeria. Nigerian Journal of Animal Science. 2020 Jul 2; 22(1):165-85. ORCID - 0000-0002-8233-093X

[30] Walugembe M, Nadiope G, Stock JD, Stalder KJ, Pezo D, Rothschild MF. Prediction of live body weight using various body measurements in Ugandan village pigs. Livestock Research for Rural Development. 2014; 26(5):1. http://lrrd.cipav.org.co/lrrd26/5/walu26096.htm[2/1/2016 8:37:30 AM]

[31] Halimani TE, Muchadeyi FC, Chimonyo M, Dzama K. Opportunities for conservation and utilisation of local pig breeds in low-input production systems in Zimbabwe and South Africa. Tropical animal health and production. 2012; 45(1):81-90. DOIhttps://doi.org/10.1007/s11250-012-0177-2

[32] Chivangulula M, Torres V, Morais J, Mário JN, Gabriel R. Multivariate evaluation of the family pig production system in Caála, Angola. Cuban Journal of Agricultural Science. 2013; 47(3).

[33] Lekule FP, Kyvsgaard NC. Improving pig husbandry in tropical resource-poor communities and its potential to reduce risk of porcine cysticercosis. Acta tropica. 2003; 87(1):111-7. doi:10.1016/S0001-706X(03)00026-3

[34] K. Hammond FAO, Animal Genetic Resources, Animal Production and Health Division, Viale delle Terme di Caracalla–00100, Rome, Italy

[35] Chauvin ND, Mulangu F, Porto G. Food production and consumption trends in sub-Saharan Africa: Prospects for the transformation of the agricultural sector. UNDP Regional Bureau for Africa: New York, NY, USA. 2012. WP 2012-011:

[36] Faye B. Le rôle de l'élevage dans la lutte contre la pauvreté. Revue d'élevage et de médecine vétérinaire des pays tropicaux. 2001; 54(3-4):231-8.

[37] Madzimure J, Chimonyo M, Zander KK, Dzama K. Potential for using indigenous pigs in subsistence-oriented and market-oriented small-scale farming systems of Southern Africa. Tropical animal health and production. 2012; 45(1):135-42. DOI 10.1007/s11250-012-0184-3

[38] Mutua, F.K., Dewey, C.E., Arimi, S.M., Ogara, W.O., Githigia, S.M., Levy, M. and Schelling, E Indigenous pig management practices in rural villages of Western Kenya. Livestock Research for Rural Development 2011; 23(7):144 **Permanent link to cite this item:** https://hdl.handle.net/10568/5369 **External link to download this item:** http://www.lrrd.org/lrrd23/7/mutu23144.htm

[39] Fasina, F.O., Shamaki, D., & Makinde, A.A. Field surveillance and laboratory diagnoses of African swine fever in Nigeria (IAEA-CN--174). International Atomic Energy Agency (IAEA). Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna (Austria); United Nations, New York, NY (United States); World Organization for Animal Health, Paris (France); World Health Organization, Geneva (Switzerland); European Commission, Brussels (Belgium); 461; 2009; p. 301-302; FAO/IAEA international symposium on sustainable improvement of animal production and health; Vienna (Austria); 8-11; IAEA-CN--174/151;

Also available on-line: http://www-naweb.iaea.org/nafa/aph/BookOfExtendedSynopses.pdf; 4 refs, 1 tab

[40] Munzhelele P. Evaluation of the production systems and constraints of smallholder pig farming in three agro-ecological zones of Mpumalanga province, South Africa. MSc (Agric) thesis, University of South Africa. 2015

[41] Kimbi EC, Mlangwa J, Thamsborg S, Mejer H, Lekule FP. Smallholder pig marketing systems in the Southern Highlands of Tanzania. Journal of Natural Sciences Research. 2016; 6(14):87-98. www.iiste.orgISSN 2224-3186. ISSN 2225-0921

[42] Gcumisa ST. The untold story of the pig farming sector of rural Kwazulu-Natal: a case study of uThukela district (Doctoral dissertation, University of South Africa). MSc thesis.2013 Available at: http://uir.unisa.ac.za/bitstream/handle/10500/14146/dissertation_gcumisa_st.pdf?sequence =1.

[43] Mokoele JM, van Rensburg LJ, Van Lochem S, Bodenstein H, Du Plessis J, Carrington CA, Spencer BT, Fasina FO. Overview of the perceived risk of transboundary pig diseases in South Africa. Journal of the South African Veterinary Association. 2015; 86(1): 1-9. http://dx.doi.org/10.4102/jsava.v86i1.1197

[44] Madec F, Geers R, Vesseur P, Kjeldsen N, Blaha T. Traceability in the pig production chain. Revue Scientifique et Technique-Office International des Epizooties. 2001; 20(2):523-37.

[45] Bester, J.; Kusel, U.S. Early domesticated animals in South Africa. In Proceedings of the 4th Global Conference on Conservation of Domestic Animal Genetic Resources, Lallitpur, Nepal, 1998;17-21

[46] FAO STAT. FAO Statistics Division: Food and Agriculture Organization of the United Nations. 2018

[47] Susan Macmillan: Uganda: Where a pig in the backyard is a piggybank for one million households–and rising viewed on ILRI 2014 https://clippings.ilri.org/2014/03/30/a-pig-in-the-backyard-a-piggybank-for-one-million-households-in-uganda/ on August 6, 2020

[48] Obayelu AE, Ogunmola OO, Sowande OK. Economic analysis and the determinants of pig production in Ogun State, Nigeria. Agricultura Tropica et Subtropica. 2017; 50(2):61-70. DOI: 10.1515/ats-2017-0007

[49] Dietze K. Pigs for prosperity. FAO diversification booklet. Rome 2011(15)...58; ISSN**:** 1810-0775 **Record Number:** 20123247945

[50] Mashatise E, Hamudikuwanda H, Dzama K, Chimonyo M, Kanengoni A. Socio-economic roles, traditional management systems and reproductive patterns of Mukota pigs in semi-arid north-eastern Zimbabwe. Bunda Journal of Agriculture, Environmental Science and Technology. 2005; 3(1):97-105. ISSN: 1726-3220 Record Number: 20083325126.

[51] Ouma EA, Dione MM, Lule PM, Pezo DA, Marshall K, Roesel K, Mayega L, Kiryabwire D, Nadiope G, Jagwe J. Smallholder pig value chain assessment in Uganda: results from producer focus group discussions and key informant interviews 2015; ILRI Project Report. Nairobi, Kenya: ILRI. ISBN 92-9146-400-7 http:// creativecommons.org/licenses/by-nc-sa/3.0

[52] Muhanguzi D, Lutwama V, Mwiine FN. Factors that influence pig production in Central Uganda-Case study of Nangabo Sub-County, Wakiso

district. Vet World. 2012; 5(6):346-51. doi: 10.5455/vetworld.2012.346-351

[53] Kambashi B, Picron P, Boudry C, Théwis A, Kiatoko H, Bindelle J. Smallholder pig production systems along a periurban-rural gradient in the Western provinces of the Democratic Republic of the Congo. Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS). 2014; 115(1):9-22. urn:nbn:de:hebis:34-2014020344851

[54] Adjei OD, Osei-Amponsah R, Ahunu BK. Characterization of local pig production systems in Ghana. Bulletin of Animal Health and Production in Africa. 2015; 63(4):337-42. eISSN: 0378-9721

[55] Meissner HH, Scholtz MM, Palmer AR. Sustainability of the South African Livestock Sector towards 2050 Part 1: Worth and impact of the sector. South African Journal of Animal Science. 2013; 43(3):282-97. http://dx.doi.org/10.4314/sajas.v43i3.5

[56] Ajala MK, Adesehinwa AO. Analysis of pig marketing in Zango Kataf local government area of Kaduna State, Nigeria. Tropicultura. 2008; 26(4):229-39. Tropicultura, 2008, 26, 4, 229-239

[57] Petrus NP, Mpofu I, Schneider MB, Nepembe M. The constraints and potentials of pig production among communal farmers in Etayi Constituency of Namibia. Livestock Research for Rural Development. 2011; 23(7):23-59. Retrieved October 6, 2020,http://www.lrrd.org/lrrd23/7/petr23159.htm

[58] Nsoso SJ, Mannathoko GG, Modise K. Monitoring production, health and marketing of indigenous Tswana pigs in Ramotswa village of Botswana. Livestock Research for Rural Development. 2006; 18(9):125. Last accessed 05.02.2013 URL http: //www.lrrd.org/lrrd18/9/nsos18125.htm

[59] Gcumisa ST, Oguttu JW, Masafu MM. Pig farming in rural South Africa: A case study of uThukela District in KwaZulu-Natal. Indian Journal of Animal Research. 2016; 50(4):614-620.

[60] Lichoti JK, Davies J, Maru Y, Kitala PM, Githigia SM, Okoth E, Bukachi SA, Okuthe S, Bishop RP. Pig traders' networks on the Kenya-Uganda border highlight potential for mitigation of African swine fever virus transmission and improved ASF disease risk management. Preventive veterinary medicine. 2017 1; 140:87-96. https://doi.org/10.1016/j.prevetmed.2017.03.005

[61] Montsho T, Moreki JC. Challenges in commercial pig production in Botswana. Journal of Agricultural Technology. 2012; 8(4):1161-70. Journal of Agricultural Technology 2012 Vol. 8(4): 1161-1170 Available online http://www.ijat-aatsea.com ISSN 1686-9141

[62] Awosanya EJ, Olugasa B, Ogundipe G, Grohn YT. Sero-prevalence and risk factors associated with African swine fever on pig farms in southwest Nigeria. BMC Veterinary Research. 2015 1; 11(1):133. DOIhttps://doi.org/10.1186/s12917-015-0444-3

[63] Mbuthia JM, Rewe TO, Kahi AK. Evaluation of pig production practices, constraints and opportunities for improvement in smallholder production systems in Kenya. Tropical animal health and production. 2015; 1; 47(2):369-76. DOI: 10.1007/s11250-014-0730-2

[64] Halimani TE, Mapiye O, Marandure T, Januarie D, Imbayarwo-Chikosi VE, Dzama K. Domestic free-range pig genetic resources in Southern Africa: progress and

prospects. Diversity. 2020; 12(2):68; doi: 10.3390/d12020068 . www.mdpi.com/journal/diversity

[65] Antwi M, Seahlodi P. Marketing constraints facing emerging small-scale pig farmers in Gauteng province, South Africa. Journal of Human Ecology. 2011 1; 36(1):37-42. https://doi.org/10.1080/09709274.2011.11906415

[66] Atherstone C, Galiwango RG, Grace D, Alonso S, Dhand NK, Ward MP, Mor SM. Analysis of pig trading networks and practices in Uganda. Tropical animal health and production. 2019; 51(1):137-47.Tropical Animal Health and Production 2019; 51:137-147 https://doi.org/10.1007/s11250-018-1668-6

[67] Mutua F, Arimi S, Ogara W, Dewey C, Schelling E. Farmer perceptions on indigenous pig farming in Kakamega district, Western Kenya. Nordic Journal of African Studies. 2010; 19(1):43-.57 https://www.njas.fi/njas/article/view/213

[68] Matabane MB, Nethenzheni P, Thomas R, Netshirovha TR, Norris D, Nephawe KA, Nedambale TL. Status of the smallholder pig farming sector in Gauteng Province of South Africa. Applied Animal Husbandry & Rural Development. 2015; 8(1):19-25. Corpus ID: 53520281

[69] Chabo RG, Malope P, Babusi B. Pig productivity: A case study for South Eastern Botswana. Livestock research for rural development. 2000; 12(3):1-6 http://www.cipav.org.co/lrrd/lrrd12/3/cha123.htm

[70] Moreki J C and Mphinyane H G: Opportunities and challenges of pig production in Botswana. *Livestock Research for Rural Development.* 2011; *23(4)* Retrieved October 6, 2020, from http://www.lrrd.org/lrrd23/4/more23087.htm

[71] Levy M. *Challenges and opportunities of small-holder pig production and marketing in Western Kenya* (Doctoral dissertation). Thesis presented to The University of Guelph In partial fulfilment of requirements for the degree of Doctor of Philosophy in Population Medicine Guelph, Ontario, Canada. 2014

[72] Kagira JM, Maingi N, Kanyari PW, Githigia SM, Ng'ang'a JC, Gachohi JM. Seroprevalence of Cysticercus cellulosae and associated risk factors in free-range pigs in Kenya. Journal of Helminthology. Cambridge University Press 2010; 84, 398-403 doi: 10.1017/S0022149X10000076.

[73] Cupido M. An insight into the livelihood of small-scale pig farmers in the Western Cape, South Africa. Thesis is presented in fulfilment of the requirements for the degree of Master of Science in Animal Sciences at Stellenbosch University Animal Sciences, Faculty of Agric Sciences, 2020

[74] Kagira JM, Kanyari PW, Maingi N, Githigia SM, Karuga JW. Characteristics of the smallholder free-range pig production system in western Kenya. Tropical animal health and production. 2010 1; 42(5):865-873. DOI 10.1007/s11250-009-9500-y

[75] Mokoele JM, Spencer BT, Van Leengoed LA, Fasina FO. Efficiency indices and indicators of poor performance among emerging small-scale pig farmers in the Limpopo Province, South Africa. Onderstepoort Journal of Veterinary Research. 2014; 81(1):1-2. http:// dx.doi.org/10.4102/ojvr. v81i1.774

[76] Oladele OI, Kolawole AE, Antwi MA. Knowledge of biosecurity among livestock farmers along border villages of South Africa and Botswana. Asian Journal of Animal and Veterinary

Advances. 2013; 8(7):874-884. **DOI :** 10.3923/ajava.2013.874.884

[77] Adewumi MO, Falola A, Olonade TE. Profitability, technical efficiency and constraints to pig production in Ogun State, Nigeria. Wayamba Journal of Animal Science. 2016; 8:1266-73. **ISSN:** 2012-578X. **URL:** http://www.wayambajournal.com/documen **Record Number:** 20173178897

[78] Dorh LE, Gindi AA, Gona A. Profitability and Constraints of Pig Production in Southern Kebbi State, Nigeria. Journal of Agricultural Economics. 2019 Jul; 5(2):569-71. Vol. 5(2), pp. 569-571, July, 2019. © www.premierpublishers.org, ISSN: 2167-0477

[79] Uddin IO, Osasogie DI. Constraints of Pig Production in Nigeria: A Case Study of Edo Central Agricultural Zone of Edo State. Asian Research Journal of Agriculture. 2016 Dec 24:1-7. DOI: 10.9734/ARJA/2016/30187.

[80] Kouam MK, Jacouba M, Moussala JO. Management and biosecurity practices on pig farms in the Western Highlands of Cameroon (Central Africa). Veterinary Medicine and Science. 2020 Feb; 6(1):82-91. DOI: 10.1002/vms3.211

[81] Mutua FK, Dewey C, Arimi S, Ogara W, Levy M, Schelling E. A description of local pig feeding systems in village smallholder farms of Western Kenya. Tropical animal health and production. 2012; 44(6):1157-62. https://doi.org/10.1007/s11250-011-0052-6

[82] Carter NA. Enhancing pig productivity on East African smallholder farms (Doctoral dissertation). Enhancing Pig Productivity on East African Smallholder Farms by Natalie Ann Carter A Thesis presented to The University of Guelph In partial fulfilment of requirements for the degree of Doctor of Philosophy in Population Medicine 2015

[83] Duniya KP, Akpoko JG, Oyakhilomen O, Nandi JA. Measurement of Pig Production Profitability in Zangon Kataf and Jema'a Local Government Areas of Kaduna State, Nigeria. British Journal of Applied Science and Technology. 2013 3(4):1455-1463. doi: https://doi.org/10.9734/BJAST/2014/4137

[84] Mphinyane HG. Piggery Section Annual Report 2008/9. Ministry of Agriculture. Gaborone. Botswana. 2009.

[85] Shiferaw B, Hellin J, Muricho G. Improving market access and agricultural productivity growth in Africa: What role for producer organizations and collective action institutions? Food Security. 2011 Dec 1; 3(4):475-89. ISSN 1876-4517 Food Sec. DOI 10.1007/s12571-011-0153-0

[86] Ironkwe MO, Amefule KU. Appraisal of indigenous pig production and management practices in Rivers State, Nigeria. Journal of Agriculture and Social Research (JASR). 2008 Aug 11; 8(1):1-7. Journal Of Agriculture and Social Research (JASR) Vol. 8, No.1, 2008

[87] LeBlanc SJ, Lissemore KD, Kelton DF, Duffield TF, Leslie KE Major advances in disease prevention in dairy cattle. Journal of Dairy Science, 2006; 89 (4), 1267-1279.https://doi.org/10.3168/jds.S0022-0302(06)72195-6

[88] Shahudin MS, Ghani AA, Zamri-Saad M, Zuki AB, Abdullah FF, Wahid H, Hassim HA. The Necessity of a Herd Health Management Programme for Dairy Goat Farms in Malaysia. Pertanika Journal of Tropical Agricultural Science. 2018; 41(1):1 - 18. ISSN: 1511-3701

[89] AfrII 2016 Piggery Production Manual: How to Rear Pigs using The Deep Litter System (DLS) or Fermented Bed Technology (FBT). Africa Innovations Institute, Kampala, 2016; 54pp

[90] Rekwot PI, Abubakar YU, Jegede JO. Swine production characteristics and management systems of smallholder piggeries in Kaduna and Benue States of north central Nigeria. Nigerian Veterinary Journal. 2003; 24(2):34-40.

[91] Nwanta JA, Shoyinka SV, Chah KF, Onunkwo JI, Onyenwe IW, Eze JI, Iheagwam CN, Njoga EO, Onyema I, Ogbu KI, Mbegbu EC. Production characteristics, disease prevalence, and herd-health management of pigs in Southeast Nigeria. Journal of Swine Health and Production. 2011; 19(6):331-9. This article is available online at http://www.aasv.org/shap.html

[92] Wabacha J K, Gitau G K, Nduhiu J M, Thaiya A G, Mbithi P M F, Munyua, S J M An outbreak of urticarial form of swine erysipelas in a medium-scale piggery in Kiambu District, Kenya. Journal of the South African Veterinary Association 1998; 69(2): 61-63. 0038-2809

[93] Mulumba-Mfumu LK, Saegerman C, Dixon LK, Madimba KC, Kazadi E, Mukalakata NT, Oura CA, Chenais E, Masembe C, Ståhl K, Thiry E. African swine fever: update on Eastern, Central and Southern Africa. Transboundary and emerging diseases. 2019; 66(4):1462-80.DOI: 10.1111/tbed.13187

[94] Kouam MK, Ngueguim FD, Kantzoura V. Internal Parasites of Pigs and Worm Control Practices in Bamboutos, Western Highlands of Cameroon. Hindawi Journal of parasitology research. 2018 Nov 21; 2018. https://doi.org/10.1155/2018/8242486

[95] Pitman, D. (2010). The epizootiology of helminthes Ascarops strongylina (Rud) and Physocephalus sexalatus (Molin) in wild pigs (Sus scrofa L). Zeittschrift Fur Jagdwissenschaft, *18*, 6-15.

[96] Babatunde GM, Fetuga BL. Pig production in Nigeria, possibilities and problems. Proceedings of the Agricultural Society of Nigeria, Illorin. 1990; 10:12-28.

[97] Adebisi OR. Gastro-intestinal helminths and public health: Overview of a neglected sector. The Internet Journal of Veterinary Medicine. 2008; 4(2):72-8.

[98] Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), 2014, Pig population and pork production (South Africa), viewed 04 June 2014, from http://faostat.fao.org/site/573

[99] Fasina FO, Lazarus DD, Spencer BT, Makinde AA, Bastos AD. Cost implications of African swine fever in smallholder farrow-to-finish units: Economic benefits of disease prevention through biosecurity. Transboundary and emerging diseases. 2012 Jun; 59(3):244-55.https://doi.org/10.1111/j.1865-1682.2011.01261.x

[100] Missohou A, Niang M, Foucher H, Dieye PN. Pig production systems in lower Casamance (Senegal). Cahiers d'Etudes et de Recherches Francophones Agricultures (France). 2001; 10 (6); 405-408

[101] Moreki JC, Chiripasi SC, Montsho T, Chibua R, Gabanakgosi K. Prevalence of poultry diseases and parasites in Botswana. Online Journal of Animal and Feed Research. 2011; 1(5): 214-217. Journal homepage: http://www.ojafr.ir

[102] Dione MM, Ouma EA, Roesel K, Kungu J, Lule P, Pezo D. Participatory

assessment of animal health and husbandry practices in smallholder pig production systems in three high poverty districts in Uganda. Preventive veterinary medicine. 2014; 117 (3-4):565-576. http://dx.doi.org/10.1016/j.prevetmed.2014.10.012

[103] Karimuribo E D, Chenyambuga S W, Makene V W and Mathias S 2011: Characteristics and production constraints of rural-based small-scale pig farming in Iringa region, Tanzania. *Livestock Research for Rural Development.2011 (23), Article #172.* Retrieved October 6, 2020, from http://www.lrrd.org/lrrd23/8/Kari23172.htm

[104] MacRae J, O'Reilly L, Morgan P. Desirable characteristics of animal products from a human health perspective. Livestock Production Science. 2005; 94(1-2):95-103. https://doi.org/10.1016/j.livprodsci.2004.11.030

[105] Bamaiyi PH. Factors militating against animal production in Nigeria. International Journal of Livestock Research. 2013; 3(2):54-66. ISSN 2277-1964 ONLINE www.ijlr.org May'13

[106] Igbokwe IO, Maduka CV. Maladies affectant la production porcine au Nigeria: synthèse des questions et des défis actuels. Revue d'élevage et de médecine vétérinaire des pays tropicaux. 2018 Jul 3; 71(1-2):87-95. DOI : 10.19182/remvt.31290

[107] Nantima N, Ocaido M, Ouma E, Davies J, Dione M, Okoth E, Mugisha A, Bishop R. Risk factors associated with occurrence of African swine fever outbreaks in smallholder pig farms in four districts along the Uganda-Kenya border. Tropical animal health and production. 2015; 47(3):589-595. https://doi.org/10.1007/s11250-015-0768-9

[108] Ikwap K, Jacobson M, Lundeheim N, Owiny D O, Nasinyama G W, Fellstrom C and Erume J Characterization of pig production in Gulu and Soroti districts in northern and eastern Uganda. Livestock Research for Rural Development. 2014; 26(4):74, Retrieved October 6, 2020, from http://www.lrrd.org/lrrd26/4/ikwa26074.htm

[109] Chiduwa, G., Chimonyo, M., Halimani, T.E., Chisambara, S.R. and 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. https://doi.org/10.1007/s11250-007-9071-8

[110] Olugasa BO, Emikpe BO, Oluwayelu DO, Cadmus SI, Ayinmode AB, Oluwole OE. Field Evaluation of Immunogenicity of Five Commercial Vaccines Against Newcastle Disease in Poultry Farms in Ibadan, Nigeria. Nigerian Veterinary Journal. 2012; 33(2).*Nigerian Veterinary Journal*, VOL: 33 (2) 475-482eISSN: 0331-3026

[111] Tekle T, Tesfay A, Kifleyohannes T. Smallholder pig production and its constraints in Mekelle and southern zone of Tigray region, north Ethiopia. Livestock Research for Rural Development. 2013; 25(10):1-5. *Article #184.* Retrieved October 6, 2020, from http://www.lrrd.org/lrrd25/10/tekl25184.htm

[112] Chah JM, Nwobodo CE, Utaka MN, Asadu AN. Pig health management strategies among farmers in Enugu state, Nigeria. Asian Journal of Agricultural Extension, Economics & Sociology. 2016 Mar 28:1-9. DOI: 10.9734/AJAEES/2016/24934

[113] Braae UC, Penrith ML, Ngowi HA, Lekule F, Johansen MV. Awareness concerning optimal pig production Animal Welfare 2016, 25: 439-446 ISSN 0962-7286 doi: 10.7120/09627286.25.4.439

[114] Weka R, Luka P, Ogo N, Weka P. Taenia solium Cysticercosis in Pigs and

Human: A Review of Epidemiological Data in West Africa (1990-2019). In Overview on Echinococcosis 2020 Apr 22. IntechOpen.DOI:10.5772/intechopen.89559

[115] Weka RP, Kamani J, Cogan T, Eisler M, Morgan ER. Overview of Taenia solium cysticercosis in West Africa. Acta tropica. 2019 Feb 1;190:329-38. https://doi.org/10.1016/j.actatropica.2018.12.012

[116] Weka R. Helminth parasites of pigs and humans in north central Nigeria, with a particular focus on *Taenia solium* (Doctoral dissertation, University of Bristol).Jan 23.2020

[117] Ayizanga RA, Kayang BB, Adomako K, Asamoah L. Rural pig production systems and breeding preferences of pig farmers in northern Ghana. Ghanaian Journal of Animal Science. 2018; 9(1):49-57. https://hdl.handle.net/10568/92509

[118] Saka JO, Adesehinwa AO, Ajala MK. Incidence of African swine fever (ASF). Disease and its associated implications on pig production in Lagos State, Nigeria. Bulgarian Journal of Agricultural Science. 2010 Feb 1; 16(1):80-90.

[119] Jones G.F. Genetic aspects of domestication, common breeds and their origin. In: Rothschild MF and Ruvinsky A (eds) The Genetics of the Pig. Wallingford: CABI Publishing. 1998.

[120] Watanabe T, Hayashi Y, Kimura J, Yasuda Y, Saitou N, Tomita T, Ogasawara N. Pig mitochondrial DNA: polymorphism, restriction map orientation, and sequence data. Biochemical genetics. 1986 Jun 1; 24(5-6):385-96. Ihttps://doi.org/10.1007/BF00499094

[121] Okumura N, Ishiguro N, Nakano M, Hirai K, Matsui A, Sahara M. Geographic population structure and sequence divergence in the mitochondrial DNA control region of the Japanese wild boar (Sus scrofa leucomystax), with reference to those of domestic pigs. Biochemical genetics. 1996 Jun 1; 34(5-6):179-89. https://doi.org/10.1007/BF02407018

[122] Paszek AA, Flickinger GH, Fontanesi L, Beattie CW, Rohrer GA, Alexander L, Schook LB. Evaluating evolutionary divergence with microsatellites. Journal of Molecular Evolution. 1998 Jan 1; 46(1):121-126. https://doi.org/10.1007/PL00006279

[123] Dotché IO, Bankolé CB, Dahouda M, Biobou R, Bonou GA, Antoine-Moussiaux N, Dehoux JP, Thilmant P, Mensah GA, Koutinhouin BG, Karim IY. Comparison of reproductive performances of local and improved pigs reared in south Benin. Tropical Animal Health and Production. 2020; 52(2):687-98. https://doi.org/10.1007/s11250-019-02058-y

[124] Kyeyamwa H, Verbeke W, Speelman S, Opuda-Asibo J, Van Huylenbroeck G (2008). Structure and dynamics of livestock marketing in rural Uganda: constraints and prospects for research and development. Journal of International Food & Agribusiness Marketing 20(4): 59-89.