Vol. 9(7), pp. 175-183, July 2018
DOI: 10.5897/IJLP2018.0474
Article Number: 87DCE3157358
ISSN: 2141-2448

http://www.academicjournals.org/IJLP

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International Journal of Livestock Production

Full Length Research Paper

Phenotypic characterization of pigs and their production system in Liberia

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Received 30 March, 2018; Accepted 11 May, 2018

Native pig farming is an important component of rural farming systems in Liberia but the population has recently stagnated, due to the absence of a comprehensive improvement and conservation program. A survey was conducted to measure the phenotypic morphometric parameters and production system of native and exotic pigs of Liberia. The survey was carried out in 15 Counties of Liberia and covered 545 animals from 264 farms. A pre-tested structured questionnaire, group discussion and in-depth interviews were the tools used in data collection. Phenotypic descriptors were directly measured using a measuring tape. The main pig breeds encountered were Landrace, Large White/Yorkshire and native pigs. The sampled pigs had predominantly smooth skin (91%), solid/uniform coat color pattern (80%) and straight head profile (82%). Mean adult body weight was 55.1±1.2 kg, body length 88.9±0.74 cm and chest girth 91.4± cm. The ears are prick (52%) or droopy (38%) and more pigs have long and thin snouts (74%). The pig farmers were mostly male (71%), literate (72%) and did not belong to any farmer's association and their main motivation for raising pigs is income (92%). The production system is mainly commercial (51%) and subsistence (46%) based on backyard scavenging (71%) and use of local feeds (72%).

Key words: Pig characterization, genetic resources, production systems.

INTRODUCTION

Pig has a relatively high potential to contribute to increased productivity on account of their high fecundity, feed conversion efficiency, short generation interval and early maturity (Ouma et al., 2013; Mbuthia et al., 2015). Available statistics up to 2015 (USDA, 2016) indicates that pork accounted for 40% of world meat consumption followed by chicken (33%), cattle (22%) and mutton and goats (7%). Native pigs of Liberia make substantial contribution to human livelihoods, employment generation and food security as well as their superior adaptation to harsh environmental conditions and resistance to endemic diseases (MOA, 2008).

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Pigs (*Sus scrofa*) display enormous phenotypic diversity in terms of shape, colour, size, production and reproduction abilities (Osei-Amponsah et al., 2017). Although local pigs have small body sizes compared to exotic pigs, their genetic diversity could be exploited to improve on their productivity. Exploitation of genetic diversity among and within breeds of pigs will thus help identify the most productive and adapted animals for specific environments (Philipsson et al., 2011). There is a need to characterize and maintain local breeds of pigs which have variable traits suited to a particular ecological zone (FAO, 2015; Adjei et al., 2015).

Morphometric information has been used to evaluate the characteristics of various breeds of animals and could provide first-hand information on the suitability of animals for breeding (Nesamvuni et al., 2000; Mwacharo et al., 2006; Adeola et al., 2013, Adjei et al., 2015). FAO (2012) reported that information provided by phenotypic characterization studies is important for management of the animal genetic resources for conservation and food security. The swine genetic resources of Liberia need to be characterized as a basis for their genetic improvement and characterization. Adequate information on the phenotypic characteristics and production system of pigs is unknown and is essential in developing breeding, management and conservation programs. The objective of this study therefore was to carry out phenotypic characterization of native and exotic pigs of Liberia, along with their production systems in order to recommend appropriate strategies for their conservation and sustainable use.

MATERIALS AND METHODS

Scope of characterization

Liberia, a country located along the coast of West Africa covers a total area of 110,000 km^2 and has an estimated population of 4 million. Prudent planning and management of animal genetic resources (AnGR) require reliable data which are not available in Liberia. In order to overcome this challenge and help improve pig production, the Government of Liberia through a Technical Cooperation Project (TCP) with the FAO implemented by the Central Agricultural Research Institute (CARI) collected baseline data on Liberia's AnGR. This was undertaken through a survey and characterization of available AnGR and provided valuable inputs for the development of a national Strategic Action Plan on AnGR (NSAP-AnGR) for Liberia. This intervention has thus contributed to development of a medium to long-term strategy to ensure sustainable use of Liberia's AnGR and maximize their contribution to economic growth, food security and poverty reduction.

Study sites and data collection

The survey was conducted in 15 counties of Liberia using on FAO's Guidelines for phenotypic characterization of AnGR (FAO, 2012). Training of supervisors and enumerators for the survey and characterization of Liberia's AnGR took place in February, 2016. The training helped to develop human resource capacity on AnGR in Liberia and also provided training and knowledge in the various aspects of phenotypic characterization. The methodology employed for sampling and data collection has been described by Karnuah et al. (2018). Data collected included general information on household characteristics, pig production and management practices, and phenotypic characteristics (FAO, 2012). Linear and morphological measurements including body measurements such as heart girth, whither height and body length were also taken using measuring tape. Livestock characterization and production system data was collected by the team of enumerators using an electronic data capture system with the EpiCollect software application (http://www.epicollect.net/).

Data processing and analysis

Various analyses were carried out to determine the relative frequencies of various characterization parameters and the results summarized in Tables and Figures. All data analyses were done using the *Mosaic* and *Survey* Packages in R (R Core Team, 2016).

RESULTS AND DISCUSSION

Respondents and educational status

A total of 372 respondents that are pig farmers were randomly surveyed from the 15 counties of Liberia with the highest numbers coming from Monsterrado (95), Lofa (83), Nimba (47), and Bong (41) counties. The number of farmers visited and interviewed by gender, educational status and membership of livestock associations are shown in Table 1.

Male pig farmers (71%) were more than the females (29%). About 20% of the pig farmers were illiterate and the high level of literacy among farmers (82%) could have positive effects on adoption of innovative animal husbandry practices. Male farmers were relatively more educated than their female counterparts. Education helps farmers in making informed decisions, solving problems and learning new technologies (IFPRI, 2010). Most pig farmers (80%) did not belong to any pig farmers associations. The absence of well-organized farmer/ breeder associations to support governmental initiatives has hindered the effort to develop an appropriate and integrated livestock monitoring and recording systems for Liberia's AnGR (MOA, 2008). It will be advisable to encourage pig farmers to come together in associations particularly in counties where pig farming is popular such as Monsterrado, Lofa, Nimba and Bong. These associations will help to safe-guard breed utilization and conservation of swine genetic resources.

Phenotypic characterization

A total 594 adult pigs were characterized of which 38% were identify as Landrace, 21% as Large White/ Yorkshire, 17% as native pigs, 10% and Hampshire (Table 2). In Liberia, the Landrace is also referred to locally as long mouth and white pig. Local names for the Large White/Yorkshire include white pig, Boaygui and

Table 1. Characteristics of pig farmers.

Parameter	Male	Female	Total
Gender of farmers	264 (71%)	108 (29%)	372(100%)
Educational status			
Illiterate	26 (10%)	40 (37%)	66(18%)
Basic (Read and write)	68 (26%)	21 (19%)	89(24%)
Secondary	121 (46%)	37 (34%)	158(42%)
Tertiary	49 (19%)	10 (9%)	59(16%)
Total	264(71%)	108(29%)	372(100%)
Chi Square value = 39.81	df = 4	P<0.001	
Membership of Livestock Association			
Yes	49 (19%)	25 (23%)	74(20%)
No	215 (81%)	82 (77%)	297(80%)
Total	264(71%)	107(29%)	371(100%)
Chi Square value = 39.81	df = 4	P<0.001	

Table 2. Number of pigs sampled by breed.

Breed	Number	Percentage
Crossbred	48	8
Exotic	33	6
Hampshire	61	10
Landrace	229	38
Large White/Yolkshire	125	21
Native pig	99	17
Total	596	100.0

Table 3. Statistics of selected quantitative variables of sampled pigs.

Variable	Mean ± SE	n	CV%	Range
Body weight (kg)	56.9 ± 1.3	595	55	10.0 - 250.4
Body length (cm)	89.7 ± 0.7	595	19	40.6 - 149.9
Chest girth (cm)	92.3± 0.7	595	19	48.3 - 149.9
Tail length (cm)	26.3 ± 0.3	595	25	7.6 - 58.4
Ear length (cm)	19.6 ± 0.2	594	31	10.2 - 38.1

Mapuka whist the Hampshire is also known locally as Boaygui. The native pig referred to as West African Dwarf pig is also known as Mba, Saynee, Gbocho, Que Bayee, Black pig and Pepee in various part of Liberia.

Table 3 shows summary statistics of some key phenotypic characterization parameters of sampled pigs in Liberia. The mean body weight of pigs was about 57 kg with a chest girth of 92 cm.

Variation in mean phenotypic characterization parameters are as shown in Table 4 with sampled Landrace being superior in most of the parameters measured. These variations could be attributed to both breed and age effects.

The dominant body coat colour pattern of pigs in Liberia (Table 5) is solid/uniform/plain (80%), spotted (11%) and patchy/pied (8%). In fact, 82% of Landrace, 96% of Large White and 59% of local pigs had solid/uniform/plain coat colour patterns with the rest being patchy (21%) and spotted (18%). In terms of coat colour, the pigs were predominantly white (79%) with some pigs being fawn (9%) or black (7%).

The dominant ear types of pigs in Liberia were prick

Table 4. Variation in mean phenotypic characterization parameters (±SE) of sampled pigs by breed.

Breed	Body weight (kg)	Body length (cm)	Chest girth (cm)	Sample size (n)
Crossbred	53.8 ± 4.6^{b}	87.2 ± 2.8^{b}	89.4 ± 2.8^{b}	48
Exotic	59.9± 5.3^{b}	88.9 ± 3.7^{ab}	92.8 ± 3.5^{a}	33
Hampshire	41.6 ± 1.9^{c}	80.7 ± 1.3^{c}	83.3 ± 1.4^{c}	61
Landrace	63.3 ± 2.3 ^{a}	93.6 ± 1.1^{a}	96.1 ± 1.2^{a}	229
Large White/Yorkshire	49.3 ± 2.3^{c}	85.5 ± 1.4 ^{b}	88.1 ± 1.4^{bc}	125
Native pig	62.1 ± 3.2^{ab}	92.9 ± 1.8^{a}	95.3± 1.9a	99

Within columns means followed by different subscripts are significantly different (P < 0.05).

Table 5. Frequency of coat colour pattern of pigs in Liberia.

Coat colour pattern	Number	Percentage
Patchy/pied	48	8
Solid/Uniform	476	80
Spotted	67	11
Pigmented	3	1
Total	594	100

Table 6. Frequency of ear type of pigs in Liberia.

Ear type	Number	Percentage
Droopy	277	38
Prick	308	52
Lop	17	3
Semi-lop	42	7
Total	594	100

Table 7. Frequency of head profile of pigs in Liberia.

Head profile	Number	Percentage
Concave	96	16
Convex	6	1
Straight	491	83
Total	593	100

(52%), droopy (38%) and semi-lop (7%) (Table 6). Landrace shows 48% droopy and 47% prick ears, while Large Whites recorded 50% droopy and 41% prick ears. Native pigs had mostly prick (69%) and droopy ear (19%). In terms of orientation, ears of pigs projected forwards (46%) or upwards (46%).

The head profile of pigs in Liberia (Table 7) are mostly straight (83%) or concave (16%). Large White demonstrated straight head profile (95%), followed by Landrace 89% and Hampshire 84%. The native pigs exhibited straight (80%) and concave (17%) head profiles.

Liberian pigs were characterized as having straight (66%) or curly/kinked (34%) tails. Landrace exhibited 88% straight and 25% curly/kinked tails, followed by Hampshire with 64% straight and 32% curly/kinked tails. The native pigs showed 59% straight and 42% curly/kinked tails. The backline of pigs in Liberia is either straight (81%) or swayed back (19%) as shown in Table 8. Large White shows 100% straight backline, Hampshire with 97% and Landrace with 65% straight and 22% swaybacked. Native pigs demonstrated straight backline

Table 8. Frequency of backline profile of pigs in Liberia.

Backline profile	Number	Percentage
Straight	481	81
Swayed back	112	19
Slopes towards rump	1	0
Total	594	100

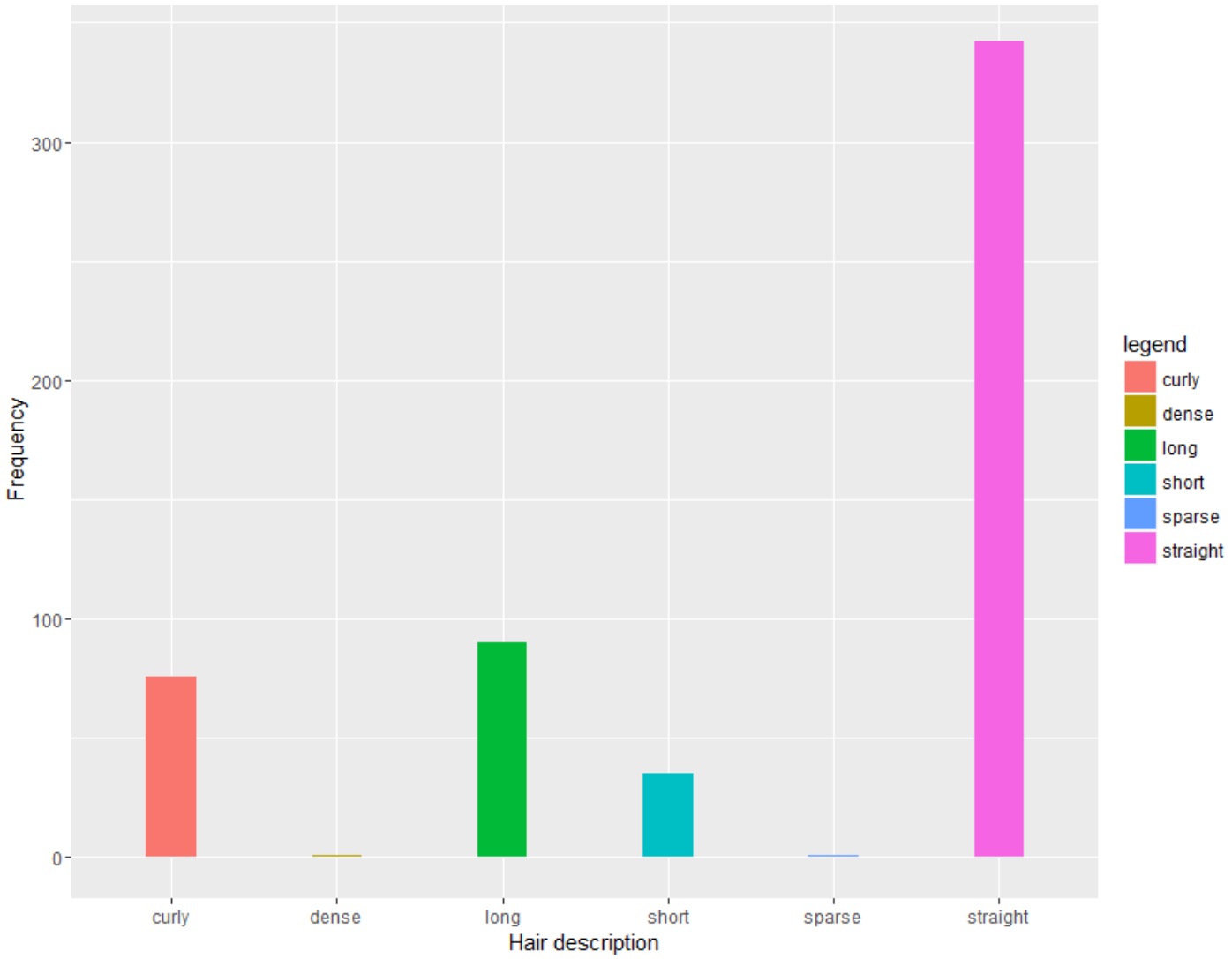

Figure 1. Bar graph showing frequency of hair description of sampled pigs.

(72%) or swaybacked (28%).

These variations can be attributed to breed and age effects (Adjei et al., 2015).

Irrespective of breed, sampled pigs showed predominantly smooth skin (91%) with a few wrinkled types (9%). The pigs were characterized mostly as having long and thin snout (74%) or short and cylindrical snout (23%). Native pigs had mostly long and thin snouts (72%) with a few having short and cylindrical snouts (28%). Hairs of pigs in Liberia can be described as straight (63%), long (17%) and curly (14%) as shown in Figure 1.

Most of the pigs were described as being moderate in temperament or friendly as shown in Figure 3. Landrace

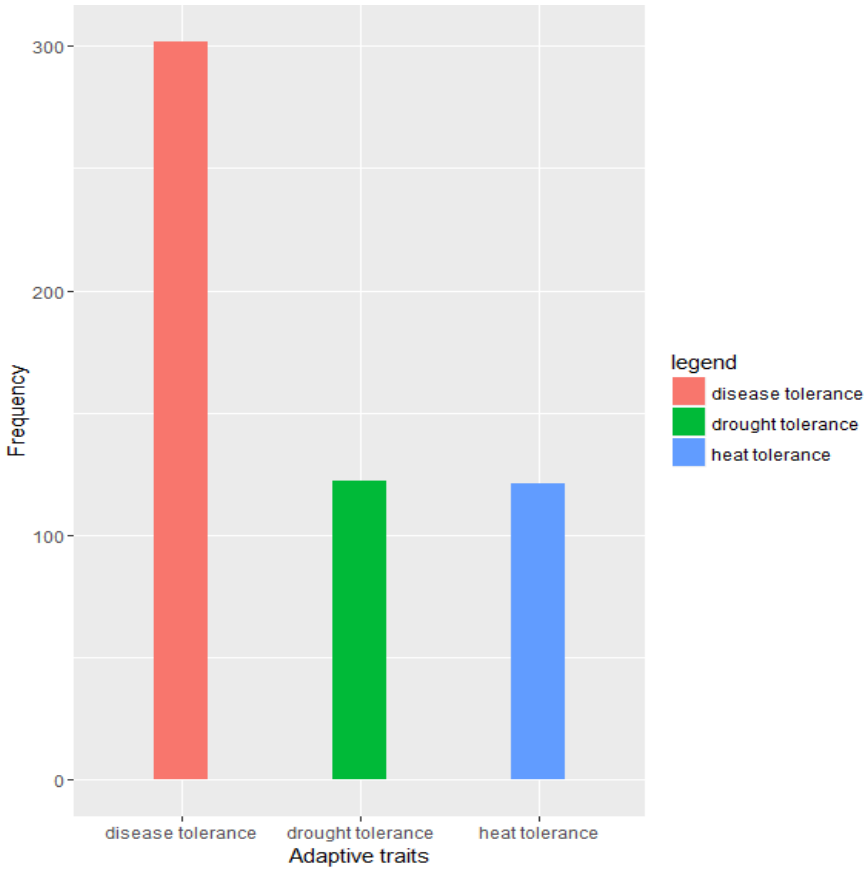

Figure 2. Bar graph showing frequency of adaptive traits of pigs in Liberia.

exhibited mostly and moderately tractable (61%) and placid/friendly temperaments (33%), while Large White exhibited moderately tractable (72%) and placid/friendly temperaments (25%). On the other hand, native pigs, exhibited aggressive/wild (32%), moderately tractable (30%), and placid/friendly temperaments (38%). The various levels of temperament observed among the Native pigs could be due the level of domestication. Some of the native pigs are kept in piggeries with daily human interactions, while others are scavengers and roam around freely in the villages and towns.

Pig farmers in Liberia indicated that disease, drought and heat tolerance as the major adaptive traits. The farmers stressed the importance of disease tolerance, but also giving attention to heat and drought tolerance. In Large White 71% showed disease tolerance, followed by native pigs 68% and Landrace 50% as shown in Figure 2. Native pigs are normally known for disease and heat tolerance to their adaptability of the ecosystem (Osei-Amponsah et al., 2017).

Production system characterization

Pig farming in Liberia is a predominantly commercial activity with over 75% of farmers in commercial production systems with peasant farming comprising about 20% and breeding and multiplication making up of only 4%. These data indicate very weak infrastructure for animal breeding in the Liberia livestock system. Pigs in Liberia are kept mostly housed with 71% of pig farmers providing permanent structures and 24% providing sheds. Only 5% of pig farmers provided no housing for their stock. The main reason for the high level of housing provision is the fact that most farmers are keeping exotic breeds such as the Landrace, Large White, and Hampshire in intensive systems. As expected therefore, most pigs in Liberia are continuously confined (82%), with a little over a tenth of pig farmers (11%) never confining their animals.

In Liberia, the main motivating factor for raising pigs is to generate income to take care of themselves and their families (MOA, 2008). About 92% of pig farmers reported income as their main motivation for pig farming. Others reasons given included pork (food) and socio-cultural factors. There are some commercial pig farms whose main motive is income and profit, but farms dedicated to training and research are very few. In general, pig farmers interviewed indicated that price of animal sold depends on either market value when it is ready for

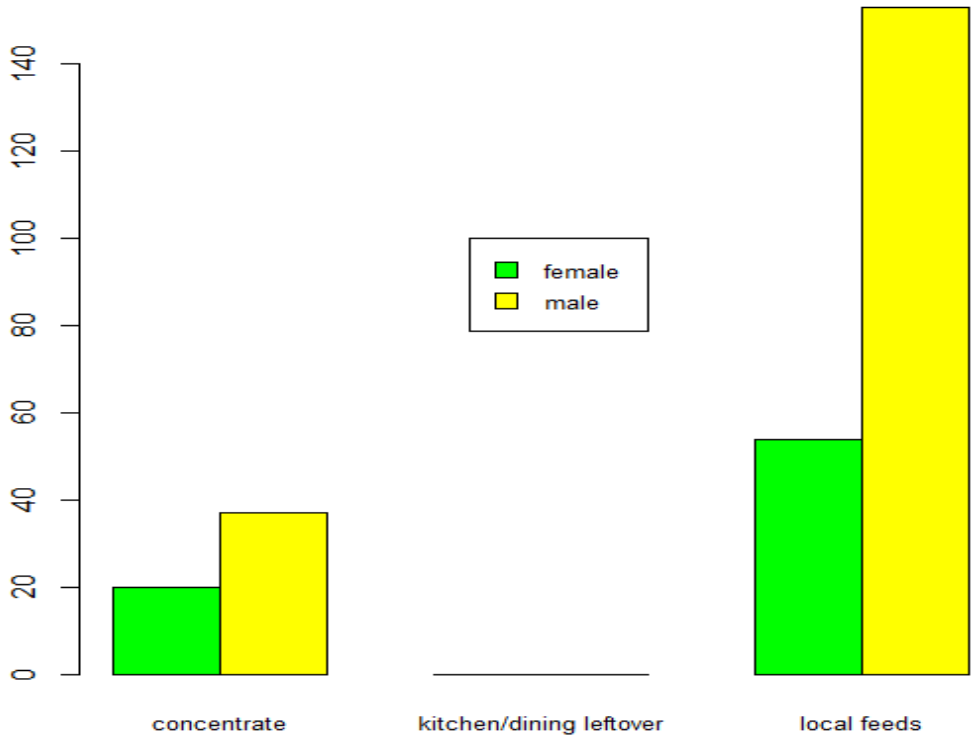

Figure 3. Proportion of type of feed given to pigs by gender of farmers.

market or when they are in financial need.

Trait of preference and economic importance for the overall pig farmers of Liberia were fast growth and overall meat production. Most farmers preferred fast growth and meat production (51%), whereas others preferred either fast growth (36%) or meat production (13%). The main sources of water for pig farming in Liberia are deep well, river/lake and pipe-born. Deep well accounted for 63%, river/lake 29% and pipe-born 8%. It is interesting to note that pipe-borne water is not the major source of watering pigs in Liberia even though there are commercial pig entities.

As shown in Figure 3, most pigs are kept in intensive and semi-intensive system and fed mostly local feeds (78%) with a small percentage of farmers providing concentrates (22%) for their pigs. In terms of availability of the feed, majority of pig farmers (65%) normally restrict their animals' access to feed, 24% usually do not restrict access to feed, while 12% occasionally do so. Therefore, pigs access to feeds in Liberia is restricted and can be explained by intensive and semi-intensive management systems, and availability of feeds.

The mating system for the livestock observed was uncontrolled, non-seasonal, natural mating involving the use of multiple sires. This is a common feature of traditional livestock systems in Africa. Although pig farming is predominantly intensive and semi-intensive, it is done with no or little monitoring of the mating system as controlled mating was just about 5% and there is a need check this particularly in the breeding herd. This lack of controlled mating has created a high level of inbreeding among pigs in Liberia. The degree of phenotypic variations among the native pigs of Liberia is reflected in body size and colour pattern as shown in their natural environment (Figure 4).

Pig farmers indicated feed cost and availability (72%), cost of veterinary medicines (12%) and poor housing (10%) as the major challenges in their operations (Table 9). The main challenges in pig farming include cost and availability of feed, housing, and endemic diseases (MOA, 2008; Mbuthia et al., 2015), Being non-ruminants, the problem of feed availability and costs is even more acute in than with ruminant species and these challenges need to be addressed not only increase productivity but motivate more to go into pig production in Liberia. The cost of accessibility to veterinary services and medicines is a huge challenge to pig farming. There is little information available on major diseases of pigs such as African swine fever, hog cholera, parasites, brucellosis and pneumonia. There is no formal research program on animal diseases and the lack of veterinarians and veterinarian medicine needs to be addressed urgently (MOA, 2008).

The Liberian pig industry is also beset with the poor infrastructure and housing facilities resulting to low productivity on one hand and a shortage of feeds and local feed ingredients necessary for profitable pig production. Record keeping is also a challenge as most

Figure 4. Native pigs in foraging for feed in their production environment.

Table 9. Challenges of pig farming in Liberia.

Challenge	Number of farmers	Percentage
Feed cost and availability	246	68
Cost of medicines	47	13
Poor Housing	46	13
Damage to property	12	3
Lack of medicines	4	1
Disease	3	1
Financial	3	1
Total	361	100.0

of the respondents could not supply most of the required productivity data and this may require building up their capacity through training workshops and regular monitoring of such farmers by the Ministry of Agriculture.

Conclusion

The pigs of Liberia are mainly made up of the Landrace, Large White/Yorkshire, native pigs (West African Dwarf pigs), Hampshire and the Duroc. Pigs in Liberia are kept in intensive and semi-intensive systems, although often with insufficient investment in housing and feeding of the stock. Pigs were characterized as primarily having smooth skin, solid/uniform coat colour pattern and white body coat colours. Their ears are prick and droopy and oriented forwards or upwards. The pigs also have straight tails, head and backline profiles with mostly long and thin snouts. The key challenges hampering the development of pig production in Liberia include feed costs and unavailability, poor housing, diseases and the high cost of veterinary medicines. The relatively low proportion of native pigs suggests a need to undertake a program to improve the sustainable use and conservation of native pigs in Liberia. The Liberian pig sector is largely dominated by exotic pig breeds requiring intensive husbandry systems and thus greater investment. However, there is need to encourage the raising of the

local pig breed which does not require much inputs in terms of housing, feeding and veterinary care and to improve the productivity through improved management, record keeping and simple genetic selection. For an important regional transboundary breed like the local West African Dwarf pig, there is a need to have national breeding and conservation centres to ensure that the breed is maintained locally, as well as cooperation across borders to ensure management of the breed population as a whole. An Open Nucleus Breeding program can be set up by CARI to breed and supply superior breeding stock to local pig farmers. Participating farmers could be supported to form an association and periodically trained on basic husbandry practices such as record keeping, herd management, feed formulation, disease prevention, value addition and market access.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

This project was funded by FAO under the Technical Cooperation Program (TCP) for Liberia (TCP/LIR/3502) with the Central Agricultural Research Institute as the implementer. The author sincerely thanks the farmers and respondents who participated in the project. Their sincere appreciation goes to all technical Staff of MOA and CARI for their contributions. Their sincere gratitude go to the then FAO Country Rep., Mr. Marc Abdala, and Staff in Liberia for their support. Special thanks to the Mr. Jesse Yuan of FAO/Liberia for his guidance and training in the utilization of EpiCollect program used in data collection.

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