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主 論 文 の 要 旨

論文題目 Evaluation of genetic diversity of the Philippine native pigs and socio-cultural perspective of farmers towards conservation management and breeding (フィリピン在来ブタの遺伝的多様性および保護管理と品種改良に対する農家の社会文化的視点の評価)

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論 文 内 容 の 要 旨

The world animal genetic resource is rapidly declining, which affects the resilience of livestock and their contribution to food security. Therefore, each country must act urgently to characterize their animals and determine the mechanisms for its utilization and conservation. This study was conducted to characterize the native pigs in the Philippines with the goal of promoting its utilization in the achievement of national food security. The objectives of this study were to describe the genetics and morphology of the pig and to determine the production objectives and trait preferences of the farmers to inform interventions, such as breeding programs and policies. We examined the native pigs and interviewed the farmers of 7 Philippine provinces, i.e., Benguet (B), Kalinga (K), Isabela (I), Nueva Vizcaya (N), Quezon (Q), Marinduque (M), and Eastern Samar (S). The provinces are further classified by region or island, i.e., North Luzon (B, K, I and N, which can be further differentiated as highland B alone, or lowland K, I and N), South Luzon (Q and M) and Visayas (S).

Genetic analysis based on the partial mitochondrial DNA D-loop region showed that the native pigs have Asian wild boar (*Sus scrofa*) origins from multiple domestication centers, such as East (D2) and Southeast Asia (D7). Furthermore, we provide evidence of the potential local domestication of the wild boar in North Luzon highlands giving rise to a group of pigs (primarily from Benguet) belonging to the Cordillera clade. We identified a total of 19 haplotypes, of which 2 belong to the Cordillera clade. In addition, we show evidence that the native pigs were not domesticated from the endemic wild pigs of the Philippines, i.e., *Sus philippensis*, *S. cebifrons*, *S. ahoenobarbus*, and *S. oliveri*, as previously

thought. However, interspecific hybridization with wild pigs was observed in Kalinga, a predominantly indigenous community in the Cordillera region of North Luzon. Microsatellite analysis showed that these pigs from Kalinga have the highest effective population size ($N_e = 420$). This result highlights the advantage of interspecific hybridization in the native pig. In contrast, majority of the remaining populations have an effective population size below 50, which is a critical point for short-term viability. Thus, immediate conservation actions are proposed, such as incentivizing the farming of native pigs to encourage more farms to utilize this breed and increase its effective population size.

On the other hand, the native pigs in each province showed sufficient genetic distance (pairwise F_{st} 0.130 to 0.427) to be considered as distinct populations. Furthermore, although exotic breeds comprise the majority of pigs in the Philippines, the native pigs are distinct from transboundary breeds (breeds found worldwide) Landrace, Large White and Duroc. The genetic distinctiveness of the native pigs of various provinces poses a challenge in their careful management, especially with regard to the maintenance of between-population genetic diversity, while at the same time maximizing the economic benefit of heterosis *via* crossbreeding (with pigs of Cordillera clade or with exotic breeds).

We further evaluated whether native pigs can be discriminated on the basis of morphology or appearance. Multivariate analysis differentiated the pigs of North Luzon lowland, South Luzon and Visayan pigs with 84% accuracy. However, the North Luzon highland pigs (Benguet) were not physically discriminated. Variables that contributed highly to the discrimination were the ratios of tail length to body length, ear length to body length, and snout length to head length. On the other hand, clustering analysis showed two groups of pigs, referred as medium-sized and small-sized pigs. The grouping did not correlate with geographic origins, suggesting that management may have played a role. The former has a body weight from 34 to 48 kg while the latter from 13 to 31 kg. Medium-sized pigs have a body length from 80 to 89 cm, while small-sized pigs have 56 to 74 cm. In addition to the physical differences of pigs between islands, their reproductive traits, i.e., teat count (average of 6, on each side) and litter size (average of $n = 7$), are moderately variable. We observed a difference of 2 teats (on each side) and about 2 piglets between the highest and the lowest record. This study shows that the native pig in the Philippines can be differentiated based on physical parameters which is consistent with their multiple genetic origins.

We acknowledge that an effective intervention is needed to promote the widespread utilization of the native pig. Understanding the farmer's preferences

of the breed as well as the challenges they encounter can help inform on these interventions. Multivariate analysis show the existence of 3 farmer typologies, i.e., (i) the income-driven farmer (type 3, $n = 58$) whose production objective is major income, desire improvement in the growth and reproduction traits of the native pig, and predominantly male, (ii) the farmer who is operating a classic mixed-farm system of crops, ruminants and poultry (type 2, $n = 217$), who raise native pigs for supplemental income, and predominantly female, and (iii) the product-oriented farmer (type 1, $n = 119$) whose production objective is also supplemental income, but relatively more educated and performs secondary processing of the meat, also predominantly female. Types 1 and 2 farmers have more years of farming experience (8 and 12 years, respectively) than type 3 (5 years), thus playing an important role in conservation and genetic improvement. Recognizing these 3 types of native pig farmers is expected to improve future interventions, for example, support for intensification on type 3 is recommended.

Majority of the farmers put priority on the growth and reproduction traits of the native pig. Although they showed a willingness to improve their production system, their production system is generally low input. The current native pig production system is characterized by a plant-based diet, a lack of vaccinations, and a lack of marketing efforts. Therefore, to achieve improved growth and reproduction despite low input production systems we recommend a genetic intervention, such as increasing feed efficiency as a breeding objective for the Philippine native pig.

This dissertation shows the complex genetics of native pigs in the Philippines and the multiple types of farmers that raise them. Intervention programs such as breeding, training and financial support systems must target their efforts to the farmer type appropriate for their purpose. For example, intensification may be appropriate for income-driven farmers of Nueva Vizcaya, while the establishment of secondary processing facilities may be appropriate for product-oriented farmers, and finally, a gender-sensitive support system must be developed for the female farmers that comprise the majority of the native pig farmers of the Philippines. The activities recommended should help address the low effective population size of the native pig and to promote its widespread utilization and conservation.