

## Perspectives of the livestock sector in the Philippines: A review

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### SUMMARY

*The Philippine livestock industry is a vital component in the country's agricultural sector. It contributes around 18.23 percent of the gross output value in agriculture and provides livelihood to many people living in rural areas, signifying its importance with regard to the country's economy. The constantly increasing demand for animal protein associated with the increase of the world's population led to the intensification of livestock production, realized through the various initiatives implemented by the government, such as the import of high producing purebreds of various species. This strategy greatly influenced the country's animal genetic resource's diversity and increased food animals' population; however, it impacted the native breeds of food animals. Understanding the characteristics, performance and value of native and exotic breeds is essential to prioritize their livestock industry existence. Thus, this paper aims to characterize various native and exotic breeds of livestock in the Philippines and assess the current conservation of native animals.*

**Keywords:** native breed; exotic breed; diversity; conservation

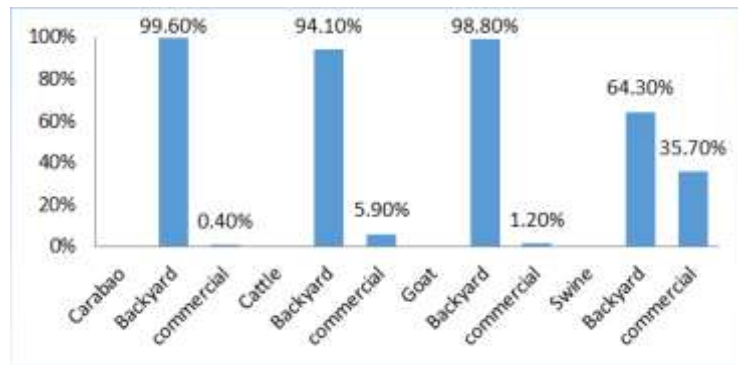
### INTRODUCTION

The Philippines is chiefly an agricultural country, with crops and animal resources as a significant contributor to its gross domestic product. As part of the fastest-growing subsectors in the country's agricultural industry, animal production provides livelihood to more or less 2.2 million households in 2015, either as sole livelihood or as part of a more extensive farming system and ranked highest among the various sectors in terms total employment in 2016 (P.S.A., 2015, 2016; Galang, 2017). In 2019, the Philippine livestock sectors' gross output value was 328.1 billion pesos (5.65 billion euros), this amount to about 18.23% of the 1.8 trillion pesos (74.16 billion Euros) gross output value in agriculture in the same year which signifies its considerable contribution to the country's economy (Sanchez, 2020). Swine, cattle, water buffalo, and goats are the primary commodities in the Philippine livestock production sector, while sheep, horses, and rabbits slowly gain popularity and importance. Livestock production in the country is broadly classified into small-scale semi-subsistence (backyard/smallholder) and commercial production systems. The classification is population-based, where farms with less than 20 heads of adult animals, or less than 41 heads of young animals, or a combination of fewer than 20 heads of adult and 22 heads of young animals are considered backyard and those that raise more than these values are considered commercial farms (F.A.O., 2003). Combined, there are millions of farms in the country, of which is majorly contributed by backyard farms, while,

officially registered commercial farms is very low (188 farms) (PSA, 2012; D.A.-B.A.I., 2021). Operations from these two different production systems vary, as backyard farming relies more on local resources. In contrast, commercial farms rely more on importing animal genetic and feed resources and operating in intensive production systems involving primary animal commodities. However, the small-scale production system has an immense contribution to the country's supply of animal protein. Most livestock species reared in the Philippines are under small-scale production (*Figure 1*).

Furthermore, the said operation also plays a vital part in the rearing of native animals, which has contributed a lot to rural farmers' daily needs. However, with the introduction of exotic breeds, native breeds of livestock in backyard farms were negatively affected and this approach also influenced the great diversity of the country's animal genetic resource (F.A.O., 2013). In order to have a better view of this diversity, it is essential to have detailed information about the various breeds of livestock that makes up the said diversity and one of the reliable method to get such information is through characterization. Characterization is used to provide reliable information regarding the animals' genetic resource and is essential in initiating successful management strategies and programs (F.A.O., 2007). Therefore, such breeds' characterization can better understand their strengths and importance in the country's livestock industry and assess the country's initiatives for conserving native animals.

Figure 1. Percent distribution of livestock inventory by farm type in the Philippines



Source: P.S.A., 2020a

**GENETIC RESOURCES IN THE PHILIPPINES**

The presence of domestic animals in the Philippines began in the Neolithic and Metal Age where evidences of faunal remains from domestic animals (pig, water buffalo, deer, and dog) were retrieved from the upper layer of the Neolithic and Metal Age Nagsabaran shell midden site in Cagayan, Northern Luzon, Philippines (Amano et al., 2013). However, there is no solid proof of livestock domestication in that period. Large ruminants such as water buffalo and cattle’s domestication, however, is proved by archaeological data, historical records and genomic evidence, which was believed to have occurred in the near east and Asia (Ajmone-Marsan et al., 2010; Pitt et al., 2018; Zhang et al., 2020). The Asian water buffalo which includes two subspecies (river and swamp-type) was independently domesticated in India about 5,000 years ago and in China about 4,000 years ago, respectively and spread throughout southern and southeast Asian regions as a

valuable domestic animal (C.A.B.I.; Borghese, 2005). Cattle domestication was long before buffaloes, which is more than 10,000 years ago in the Near East (Bollongino et al., 2012; Pitt et al., 2018). These species introduction to the Philippines was influenced by the Chinese migrants and the Spanish colonizers (Bondoc, 1998). The swamp-type water buffalo (Carabao) is reared for its meat and draft power, while river-types such as Murrah are raised for meat and dairy. Cattle are also reared for meat and dairy, however the native cattle has its limitation in terms of milk production. Native breeds and crossbreds of these species (Figure 2 and 3) are usually reared for draft purposes essential to rural small-scale farmers (F.A.O., 2003). There are several types of native cattle in the Philippines classified based on their geographical location and phenotype. Through microsatellite genotyping Aquino et al. (2006) discovered that these populations descended from three parental populations: zebu (*Bos indicus*), taurine (*Bos taurus*) and banteng (*Bos banteng*).

Figure 2. Philippine Carabao (A) and Phil-Murrah (Carabao x Murrah) (B). Photo taken at Philippine Carabao Center in Central Mindanao University

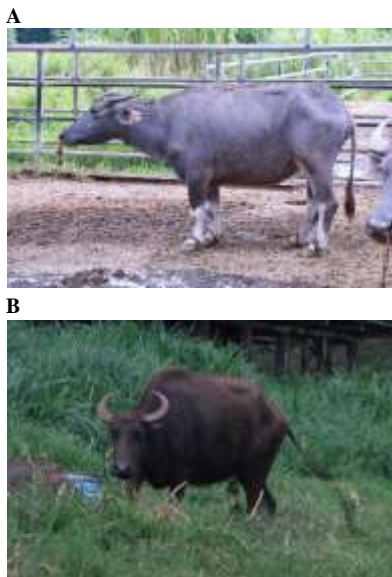


Figure 3. Philippine native cattle A: brown with black head, B: Gray and black, C: Brown, D: Mixture of gray, brown and black, Photo taken from N.B.C.R.D.C., Bukidnon by Elmer Revaldo



The small ruminants (sheep and goats) raising in the country are dominated by smallholder farmers and an excellent secondary income source. Typically, households in rural areas own diverse livestock species as they help them in their everyday lives. In some homes, goats are primarily raised for their consumption. Its meat (chevon) is prepared in many dishes, especially during special occasions such as birthdays and festivals; this makes its population higher than sheep (P.S.A., 2020a). It is believed that the native goats in the country originated from wild goats of western Asia, which Arab and Chinese traders

introduced between the 7<sup>th</sup> to 9<sup>th</sup> centuries B.C. (Devendra 1983; Bondoc, 1998). They exist in various colors, mainly black-brown and some have mixed color of brown, black, reddish-brown and white (*Figure 4*). They have small body size with an adult weight of only 15 to 30 kg. The does can only produce 66 kg of milk over a lactation period of 187 days, which is just enough for their kid. Its carcass attributes is poor compared to purebreds and upgrades signifying its low productive performance compared to exotic breeds (Malvaz, 2019; Nayga et al., 2015).

*Figure 4. Philippine native goat A: Brown and black, B: Black and white, C: Reddish brown and black, D: Mixture of white, black and brown*

A



B



C



D



The exotic breeds of dairy type (Anglo-Nubian, French Alpine, La Mancha, Saanen, and Toggenburg) and meat type (Jumna Pari and Boer) goats were introduced in the country before the second World War in the hopes of supplying the demand of meat and milk through crossbreeding as well as raising the said purebreds (Bondoc, 1998). This initiative gave rise to commercial farms, of which goats are reared either extensively or intensively. However, chevon and mutton are still rare in the public market compared to pork, beef, and poultry, which indicates its low supply. Sheep in the country are raised mainly for their meat. However, it was believed that the Philippine sheep originated from merino introduced to the country during the Spanish era (1521 to 1898). Little or no interest has been explored for sheep's wool; they are reared mainly for the same purpose as goats in rural households, but it is less popular than goats.

The previously mentioned livestock species above are far behind pigs in terms of popularity and importance in providing additional income to farmers and supplying the meat demand in the market (D.O.S.T.-P.C.A.R.R.D., 2016). The first domestication of pigs was in the Near East between 8,500 and 8,000 cal BC. (Caliebe et al., 2017). In the Philippines, it is believed that, domestic pigs were introduced around 4,000 years ago where the Chinese migrants brought them via Taiwan and the Spaniards' influence during the Spanish era (Bondoc, 1998; Piper et al., 2009). The genetic resource of pigs in the country is highly diverse and is classified into exotic standard purebreds, synthetic hybrids, Philippine wild pigs (black), and Philippine native pigs (either black or black with a white belly) (Oh et al., 2014). However, the exotic breeds of pigs and their crosses are highly productive. Some rural farmers still engage in rearing native pigs, which aided in their daily living. Through

the years of domestication and with the influence of exotic breeds, the native pigs were considered mongrels and have varied characteristics depending on the region where they are found (Baguio, 2017). To improve the productive performance of indigenous pigs and its purification, the Philippine government through the Bureau of Animal Industry (B.A.I.), National Swine and Poultry Research and Development Center (N.S.P.R.D.C.) and the Philippine Native Animal

Development (P.N.A.D.) program, initiated a breeding program which was funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (P.C.A.A.R.R.D.). Due to the diversity of native pigs in the country, the approach of the program was to select and purify the strains based on region. With this, B.A.I.-N.S.P.R.D.C. developed various strains of native pigs (*Figure 5*) and named them after the province or region of their origin.

*Figure 5. Philippine native pigs A: Benguet native pig, B: Q-Black, C: Markaduke, D: BT Black, E: BT Kalinga, F: Yookah (Source: Bar Digest, 2016; PCAARRD-DOST), G and H: Bukidnon native pigs*



These strains include (Benguet native pig (BNP), Q-Black, Markaduke, Bai Tiaong (BT) black and Bai Tiaong Kalinga, Yookah, Sinirangan and ISUbela) (The Pork Production Committee, 2004; Icamina, 2019; P.C.A.A.R.R.D.-D.O.S.T). There are various preparations for its meat, but the most popular is roasting it whole (*Lechon*). There is a steady increase in this product's demand as its meat is healthier than exotic breeds' meat, based on its higher crude protein and ash content and lower calorie levels from fat and

cholesterol (Dela Cruz, 2016). When slaughtered at the right weight (20 to 25 kg), the said product is flavorsome and its carcass recovery is comparable to commercial or exotic breeds (Abanto et al., 2012; Bondoc et al., 2017). This commands a competitive price in the market, which is beneficial to local farmers (Brion, 2016). Details regarding the history, utilization, performance, and comparison of the various native and exotic breeds of livestock in the country are presented in *Table 1, 2a, 2b, 2c, and 3*, respectively.

Table 1. Origin, utilization, and performance of various native breeds of livestock in the Philippines

Livestock species	Origin	Utilization	Performance and situation	Source
Philippine Carabao/ water buffalo ( <i>Bubalus bubalis</i> )	• China	Meat and draft	<ul style="list-style-type: none"> <li>• High endurance for work and can provide meat. Low milk yield (2.57 kg per day) in 208.2 days lactation. Its age of 1<sup>st</sup> calving is variable 3 years, 7 months to 5.3 years, depending on the management and condition.</li> </ul>	Momongan et al., 1991 Bondoc, 1998; P.C.C., 2020 N.Z.D.L.
Tamaraw ( <i>Bubalus mendorensis</i> )	• Mindoro, Philippines	Protected/conserved as it is classified as endangered	<ul style="list-style-type: none"> <li>• Critically endangered</li> </ul>	Boyles and De Leon, 2016; Huffman, 2016
Philippine native cattle ( <i>Bos indicus</i> , <i>Bos taurus</i> , <i>Bos banteng</i> )	• China and Spain	Meat, milk, and draft	<ul style="list-style-type: none"> <li>• Small (280–80 kg adult weight) and has low milk yield (1.3 liters per day). It is still raised as source of additional income.</li> <li>• Its beef has a profound taste, which the Filipinos love.</li> </ul>	Villegas and Cruz, 1958; Bondoc 1998; F.A.O., 2003 Takeshima et al., 2014, Doydora et al., 2014
Philippine native goat Dadiangas goat ( <i>Capra hircus</i> )	<ul style="list-style-type: none"> <li>• China</li> <li>• General Santos, Philippines</li> </ul>	Meat and milk	<ul style="list-style-type: none"> <li>• Small (15 to 30 kg) and has low milk yield.</li> <li>• Highly prolific, well-adapted and resistant to various diseases and has a high twinning rate (1.35).</li> </ul>	Bondoc et al., 2002, F.A.O., 2003, Susuban et al., 1990
Philippine wild swine: <i>SuscelebenensisPhilippinensisNe hring</i> , <i>Suscelebenensisnegrinus Sanborn</i> , or <i>Sus barbatus ahoenobarbusHuet</i>	• Philippines	Meat	<ul style="list-style-type: none"> <li>• Rarely seen due to deforestation, slash and burn systems, and excessive hunting, can be found in vast forestall areas.</li> </ul>	Bondoc, 1998 F.A.O., 2003 Grooves, 2008, Wild Pig, 2020
Philippine native swine ( <i>Sus scrofa</i> and <i>Sus vittatus</i> ) Varieties: Ilocos and Jaljala. <b>Old strains:</b> Berkjala, Diani, Kaman, Koronadel, and Libtong <b>New strains:</b> BNP, Q-Black, Markaduke, BT black, Yookah, BT Kalinga	• Europe and Asia	Meat	<ul style="list-style-type: none"> <li>• Reared by smallholders due to their low input and adaptability to local environmental conditions.</li> <li>• Its productivity varies (mature weight of 40 to 60 kg in 6–8 months, average litter size at birth and after weaning is 8.2 and 6.75, respectively) depending on the region and management.</li> </ul>	Bondoc, 1998, Santiago, 2010, TPS, 2020a Oh et al., 2014, Bondoc et al., 2017



Table 2a. Origin, utilization and performance of some exotic and synthetic breeds of livestock in the Philippines

Livestock species	Origin and history	Utilization	Performance	Source
<b>Water Buffalo</b>				
Murrah buffalo (River type)	<ul style="list-style-type: none"> <li>Punjab and Haryana (India)</li> <li>Live animals were introduced in the country in June 1917, frozen semen in 1982. In 1995 Bulgarian Murrah buffaloes were imported.</li> </ul>	Milk and meat	<ul style="list-style-type: none"> <li>Produce an average 4.58 kg of milk per day with a lactation length of 360.3 days. Age at 1<sup>st</sup> calving is 4.36 years and its calving interval is 15.5 months.</li> </ul>	Shrestha 1992, Bondoc, 1998, Borghese, 2005 P.C.C., 2015, P.C.C., 2018
Nili-Ravi (River type)	<ul style="list-style-type: none"> <li>Imported from Pakistan in the form of frozen semen in 1983.</li> </ul>	Milk and meat	<ul style="list-style-type: none"> <li>Average milk yield is 2,020.04 litres, lactation length 277.42 days, and calving interval 467.10 days.</li> </ul>	Bondoc, 1998, Khan 1999, Borghese, 2005 PCC, 2015
F1 Phil-Murrah	<ul style="list-style-type: none"> <li>India and Philippines</li> <li>Crossbreeding (Natural mating and or artificial insemination)</li> </ul>	Milk, meat, and draft	<ul style="list-style-type: none"> <li>Heavier birth and adult weight than native buffalo</li> <li>The average lactation yield is 3.66 kg per day with a lactation length of 297.1 days. Age at 1<sup>st</sup> calving is 4.3 to 5.16 years, depending on the management and condition.</li> </ul>	Shrestha 1992, Garillo, 1986; Delos Santos, 1987 Borghese, 2005, PCC, 2015; 2018 Momongan et al., 2019
F1 Phil-Ravi	<ul style="list-style-type: none"> <li>Pakistan, India, Philippines</li> <li>Crossbreeding (Natural mating and or artificial insemination)</li> </ul>	Milk, meat, and draft	<ul style="list-style-type: none"> <li>Heavier birth and adult weight than native buffalo.</li> <li>The average lactation yield is 3.96 kg per day with a lactation length of 292.6 days.</li> <li>Age at 1<sup>st</sup> calving is 5.11 years</li> </ul>	Shrestha 1992, Garillo, 1986; Delos Santos, 1987 Bondoc, 1998, Borghese, 2005 PCC, 2015
<b>Cattle<sup>1</sup></b>				
American Brahman <sup>a</sup>	<ul style="list-style-type: none"> <li>Texas U.S.A. from four Indian breeds (Gyr, Guzerat, Nellore, and Krishna Valley) in the 1900s.</li> <li>Philippines was the 1<sup>st</sup> Asian nation to import American Brahman in 1952</li> </ul>	Meat	<ul style="list-style-type: none"> <li>Hybrid vigor, do well on poor range and tolerate drought conditions.</li> <li>Dominant breed raised in commercial farms.</li> <li>Crossbred (Native x Brahman) is prominent in the country.</li> </ul>	Cutrer, 2020, Akerman, 1992, Bondoc, 1998
Simmental <sup>a</sup>	<ul style="list-style-type: none"> <li>Middle Ages, Simme Valley.</li> <li>Cross between large German cattle and a smaller breed indigenous to Switzerland.</li> </ul>	Meat	<ul style="list-style-type: none"> <li>High, long-term productivity, calving ease, short intervals between calving and efficient feed converters.</li> </ul>	Bondoc, 1998, TCS, 2020a
Hereford <sup>a</sup>	<ul style="list-style-type: none"> <li>Draught ox descended from the small red cattle of Roman Briton and from a large Welsh breed once numerous along with England and Wales border.</li> </ul>	Meat	<ul style="list-style-type: none"> <li>High calf crops, docile, early maturing, and long productive life.</li> <li>Miniature Hereford (Hereford x Native cattle), raised in minimal inputs.</li> </ul>	TCS, 2020b, Mindanews, 2015, Provido, 2018
Wagyu <sup>a</sup> (Japanese Black)	<ul style="list-style-type: none"> <li>1944, developed through selective intra-breeding.</li> <li>Introduction to Philippines is unclear. However, it is believed that it got in through frozen semen or embryo transfer (ET).</li> </ul>	Meat	<ul style="list-style-type: none"> <li>Early maturing, high meat quality, higher ratio of unsaturated fats.</li> <li>Purebreds and Crossbreds (native x Wagyu), (Brahman x Wagyu) are reared in Umalag Farms, and N.B.C.R.D.C., Bukidnon, Mindanao.</li> </ul>	TCS, 2020c Wagyuinternational, 2013 Gotoh et al., 2018
Holstein Friesian <sup>b</sup>	<ul style="list-style-type: none"> <li>North Holland and Friesland, Netherlands, 2000 years ago.</li> <li>Strict selective breeding lead to the breed's high productivity and efficiency.</li> </ul>	Milk	<ul style="list-style-type: none"> <li>In the Philippines, the purebreds have moderate performance.</li> <li>Crossbreds, 50% to 75% Holstein blood perform better than purebreds.</li> <li>Distribution is facilitated by the National Dairy Authority (NDA)</li> </ul>	TCS, 2020d Olson, et al., 2009, Berman, 2011, Coffey et al., 2016, Alqaisi et al., 2019, N.D.A.
Jersey <sup>b</sup>	<ul style="list-style-type: none"> <li>British Isles, 1700</li> </ul>	Milk	<ul style="list-style-type: none"> <li>High fertility, short calving interval, early maturing, long productive life.</li> <li>Nutritional value of its milk is greater than other dairy cattle breeds.</li> </ul>	Hermosura and Mordeno, 1982, Olson et al., 2009, Berman, 2011

Table 2a. continued

Livestock species	Origin and history	Utilization	Performance	Source
<b>Cattle<sup>1</sup></b>				
Sahiwal <sup>c</sup>	• Punjab region, Indian-Pakistani border.	Meat and milk	• Heat and bloat tolerant, heaviest milkers of all zebu breeds. Tick, parasite and drought resistant.	TCS, 2020e Bondoc 1998, F.A.O., 2003
Holstein x Sahiwal <sup>d</sup>	• Imported from New Zealand in the mid 1980's.		• Adapt better to Philippine condition. • Average lactation is 1,392 ± 707 kg in 278 ± 100 days lactation and age at 1 <sup>st</sup> lactation is 2.4 years. • Calving interval is 430 ± 84 days.	Bondoc 1998, F.A.O., 2003,
Simbrah <sup>d</sup>	• Hot, humid areas of the Gulf Coast of USA (Texas to Florida) in the late 1960's.	Meat	• Ranges from 3/8 to 3/4 Simmental and 1/4 to 1/8 Brahman. • Excellent growth rate and outstanding maternal ability. • Often crossed with native cattle in the country.	TCS, 2020f Cunningham, 1991, Bondoc, 1998, Simbra.org.

<sup>1</sup> Breeds of cattle that were introduced in the country are classified into various types (<sup>a</sup> beef, <sup>b</sup> dairy and <sup>c</sup> dual-purpose) which came from tropical and temperate countries all over the world. There also some <sup>d</sup> composite breeds, however its population is quite low. Although there were a lot of various breeds introduced in the country only few breeds remain, particularly those breeds that are well adapted in the country's climatic condition such as Brahman (F.A.O., 2003). With this, crossbreeding of exotic and Philippine native cattle was rampant leading to the non-descript cattle population in the country (Bondoc, 1998). Philippine Carabao Center, National Beef Cattle Research and Development Center

Table 2b. Origin, utilization and performance of some exotic breeds of goat in the Philippines

Livestock species	Origin and history	Utilization	Performance	Source
<b>Goat<sup>1</sup></b>				
Anglo-Nubian	• 1850, crossbreed between the common English and Nubian goat from Nubia, Upper Egypt, Abyssinia and South Africa.	Meat and milk	• Largest breed of dairy goat (75 kg). • Its average milk yield is 1.15kg per day in a 127 days lactation period with a twinning rate of 1.14. • It is used to upgrade the native goats.	British goat society, DPI-NSW, 2020a, Parawan, 1987, Bondoc et al., 2018
French Alpine	• French Alps.	Milk	• In Philippine condition, they can reach 35 to 45 kg and can produce 1.23kg of milk per day for 125 days and a twinning rate of 1.20.	French genetics: Alpine, Tablizo and Araneta, 1987
Toggenburg	• Toggenburg Valley of Switzerland.	Milk	• In the Philippines, it produces an average of 0.63 kg milk per day (3.6% butterfat) for 105 days, and has a twinning rate of 1.24.	DPI-NSW, 2020b, Villar et al., 1984, Bondoc, 1998
Saanen	• Originated in the Saanen valley in the south of Canton Berne, Switzerland in 1893.	Milk	• In the Philippines, they weigh around 40-55 kg, produce 1.09 kg of milk per day (4.3 % butterfat) in a 98 day lactation period and have a twinning rate of 1.04.	Goat extension, 2019, Villar et al., 1984, Bondoc, 1998, Liang and Paengkoum, 2019
Boer	• South Africa, during the 19 <sup>th</sup> century	Meat	• Docile, high fertility, fast-growing (adult weight: 86-154kg) and high quality lean. • In the country Boer goats are often crossed with Anglo-Nubian and native.	American Boer Goat Association, Breeds of livestock, Cassey and Van Niekerk, 1988, FAO, 2003

<sup>1</sup> Importation of exotic breeds of goats in the country is facilitated by the BAI a component of the Department of Agriculture (DA).



Table 2c. Origin, utilization, and performance of some exotic breeds of swine in the Philippines

Livestock species	Origin and history	Utilization	Performance	Source
<b>Swine</b>				
Duroc	<ul style="list-style-type: none"> <li>• 1812, USA (New York and New Jersey).</li> <li>• 1823, developed through selective breeding.</li> </ul>	Meat	<ul style="list-style-type: none"> <li>• Rapid growth, early maturing, deep body, broad ham, and shoulder.</li> <li>• In the Philippines, it is raised as terminal boar for market hogs.</li> </ul>	TPS, 2020b Cameron, 2010, Hagan and Etim, 2019,
Landrace	<ul style="list-style-type: none"> <li>• 1895, Denmark.</li> <li>• Cross between the imported Large White boars from England and the Danish native pigs.</li> </ul>	Meat	<ul style="list-style-type: none"> <li>• Sows are prolific, large litter size and exceptionally heavy milkers.</li> <li>• Purebreds and Crossbreds are used as sow lines in the Philippines.</li> </ul>	TPS, 2020c Cameron, 2010, Hagan and Etim, 2019, P.I.C., 2020
Large white	<ul style="list-style-type: none"> <li>• 1868, owes its origin to the old Yorkshire breed.</li> <li>• One of the original founder breeds of the British Pig Association.</li> </ul>	Meat	<ul style="list-style-type: none"> <li>• Highly prolific and efficient feed converters.</li> <li>• In the Philippines, purebreds and their crosses with landrace are raised as sow lines.</li> </ul>	TPS, 2020d Bondoc 1998, F.A.O., 2003
Pietrain	<ul style="list-style-type: none"> <li>• 1950-51, Pietrain Village, Belgium</li> <li>• The breed became popular in Belgium and was exported to other countries.</li> </ul>	Meat	<ul style="list-style-type: none"> <li>• Popular terminal sire in the country. Yields high lean meat, but it is often associated with Porcine Stress Syndrome's halothane gene, limiting its use in commercial farms.</li> </ul>	TPS, 2020e, Arganosa et al., 1988, Bondoc, 1998 F.A.O., 2003

<sup>1</sup> Importation of exotic breeds of goats in the country is facilitated by the BAI, a Department of Agriculture (DA) component.

**POLICIES, STRATEGIES AND PROGRAMS OF ANIMAL GENETIC RESOURCE IN THE PHILIPPINES**

The country's concern for animal genetic resources began in the 1935 Constitution of the Philippine Government when it first expressed its intention to "conserve and develop the nation's heritage." This has led to government agencies' establishment that focuses on agriculture (Department of Agriculture and Natural Resources; Bureau of animal industry and Bureau of plant industry). This was made more explicit when the government declared that "The State shall develop a self-reliant and independent national economy effectively controlled by Filipinos. It shall support indigenous, appropriate and self-reliant scientific and technological capabilities and their application to the country's production system and national life". This gave birth to the importation of exotic breeds to either replace and or upgrade the local stocks. During World War II, the majority of the improved and exotic stocks were wiped out. After the war, the country had the chance to renew its importation of large numbers of exotic breeding stocks with the United States Government's help. This was the beginning of the nationwide dissemination of exotic breeds through the dispersal program (F.A.O., 2003).

With the government's aim to increase the population of exotic stocks in the country, it provided generous incentives that promote private importers of commercial breeding stocks of livestock and poultry animals. In 1976, the Livestock Development Council (L.D.C.) was created under the Department of Agriculture administrative supervision to develop a livestock industry and increase the supply of livestock and livestock products and attain self-sufficiency in food commodities of animal origin. Since then, along with the B.A.I.-Animal Genetic Resource improvement and

Conservation Program, various programs were created, specific to the various commodities (Table 4), and shaped the Philippine livestock industry. Although exotic stocks are massively produced, smallholder farmers continued to keep indigenous stocks. However, generations of crossbreeding led to the reduction of native breeds, particularly on the commodities that are intensively reared (swine), and increased the population of non-descript breeds of Livestock in the country. Understanding and accepting safe and healthy food from natural origin is usually neglected in commercial livestock production. Currently, this is the trend, but is still limited to people that can afford the said product. This situation, gave rise to the country's interest in the native animal's potential to attain such a product. This was then given preferential attention by the D.A.-B.A.I. and created the Philippine Native Animal Development program through the Administrative order issued by the former Agricultural Secretary Proceso J. Alcalá in August 2, 2010. The aim was to conserve and utilize native food animals and recognize its opportunity to provide income and alleviate poverty in rural areas. With its proven potential, the said program was presented and proposed in the Republic of the Philippines' sixteenth Congress under the senate bill no. 2674 (Legacy.senate.gov.ph, 2015; Lesaca, 2016). Since then, the proposal of the Philippine Native Animal Development Act was formulated and highlighted the creation of the Philippine Animal Development Center (P.N.A.D.C.), National Livestock and Poultry Genetics (N.L.P.G.), and Native Animal Genetic Centers (N.A.R.S.C.). This has a great impact on the popularity of native animals as these can be linked to academic institutions which engage in research and development and can spread awareness of the said program to the community through extension projects.



Table 3. Comparison of native and some of the exotic breeds of livestock in the Philippines

Livestock	Traits	Productivity <sup>1</sup>	Adaptability <sup>1</sup>	Acceptability <sup>2</sup>	Source
<b>Native breeds<sup>a</sup></b>					
Philippine carabao	A source of good meat and draft animal	Low	High	High	Bondoc, 1998, Flores, 2017
Philippine native cattle	Good for the draft and has good quality meat.	Low	High	High	F.A.O., 2003, Doydora et al., 2014
Philippine native goat	Early maturing, short kidding intervals, high twinning rate.	Moderate	High	High	Bondoc et al., 2002
Philippine native swine	Prolific, early maturing (4–5 months), low F.C.R. and small mature size.	Low	High	High	Santiago, 2010, Oh et al., 2014
<b>Exotic Breeds<sup>3, a</sup></b>					
Murrah Buffalo	High milk yield and large body size.	High	High	High	PCC, 2015, Boro et al., 2020
<b>Cattle</b>					
Brahman	Hybrid vigor, heat, and insect tolerant, fast-growing and large	High	High	High	Cutrer, 2020
Holstein	Docile and high milk yield.	Moderate	Low	Low	Coffey et al., 2016
<b>Goat</b>					
Anglo-Nubian	Docile, moderate milk yield, fast-growing and large.	High	High	High	Bondoc et al., 2018
Saanen	High milk yield and milk quality	Moderate	Moderate	Moderate	Liang and Paengkoum, 2019
Boer	large body and good meat quality	High	Moderate	High	American Boer Goat Association
<b>Swine<sup>4</sup></b>					
Duroc	Efficient feed converters, and less fat.	Moderate	Moderate	Moderate	Hagan and Etim, 2019
Landrace	Long body, high carcass recovery, heavy birth weights, standard average weaning weights	High	Moderate	High	Cameron, 2010, Thiengpimol et al., 2017, Hagan and Etim, 2019
Large white	Large, large litter size, heavy birth weights, standard average weaning weights	High	Moderate	High	TPS, 2020d, Thiengpimol et al., 2017
Pietrain	Muscled ham, loin and shoulder	Moderate	Moderate	Moderate	TPS, 2020e

<sup>1</sup> Based on average performance, <sup>2</sup>Based on farmers' interest <sup>3</sup> These are the famous and mostly raised exotic breeds in the country, <sup>4</sup> Only breeder farms and genetic companies can raise these purebreds. Market hogs in the country are often 3-way and or 4-way cross from these highly productive breeds, <sup>a</sup> native breed requires low input. In contrast, exotic breeds require moderate to high inputs.



Table 4. Programs, production, and vision of the Philippine livestock industry

Livestock	Programs and research activities (production and conservation) <sup>1</sup>	Inventory, million heads <sup>2,a</sup>	Products	Past, present and future demand and trends <sup>1,3,4</sup>
Water buffalo	P.C.C., National Carabao Development Program, Carabao Genetic Improvement Program P.N.A.D.	2.90	meat and milk	<ul style="list-style-type: none"> <li>• Government initiatives in the past to increase the volume of production through the importation of exotic breeding animals affected the farmers' mentality and led to the country's dependence on such a strategy.</li> <li>• A shift in consumer preferences towards naturally produced animal food products that involve the rearing of native animals is gaining significant attention.</li> <li>• The governments' response for this trend led to the development of conservation programs.</li> <li>• It is certain that these programs will face various challenges and its sustenance will depend on the responsible people (government officials, researchers and scientist, farmers and consumers).</li> </ul>
Cattle	<b>Cattle Genetic Improvement Programs:</b> National Cattle Breeding Program, Medium Term Livestock Development Program, Establishment of Elite Herd, National Genetic Resource Improvement Program, Establishment of Animal Products Development Center <b>Dairy:</b> Philippine Dairy Corporation, N.D.A., P.N.A.D.	2.60	meat and milk	
Goat and Sheep	Australian Center for International Agricultural Research –Department of Agriculture Project: Performance Evaluation and Genetic Improvement of Small Ruminants in the Philippines. Recording system through customized breed plan, Buck and Ram Loan Program, Buck stud service in the village, P.N.A.D	3.99	meat and milk	
Swine	Swine Genetic Improvement Activities: Massive upgrading of native pigs in the 1950s, Breed Development, Characterization, selection, and breeding of native pigs through small and short-term projects: B.A.I.-N.S.P.R.D.C., P.N.A.D.	11.27	meat	

<sup>1</sup>F.A.O., 2003, <sup>2</sup>P.S.A., 2020b, <sup>3</sup>Piñol, 2016, <sup>4</sup>Lesaca, 2016

<sup>a</sup> These are the total population (native and exotic breeds) of every species of Livestock in the country. Unfortunately, there is no available data on the specific inventory of native stocks in the country. However, based on the trend, most livestock breeds raised in the country are exotic breeds and crossbreds.

## CONCLUSIONS

Native and exotic breeds of livestock in the Philippines greatly differ in character, adaptability and production performance. The introduction of modern genotypes of livestock made a significant contribution to the development of the Philippine livestock industry and with their competitive advantage over the native breeds jeopardized the existence of the latter and led to an increase of nondescript animals. Despite the fact that native breeds of livestock have low productive performance, they can be reared with low inputs and are potential source of healthy animal protein and commands a competitive price in the market. Realizing the potential of the native animals, the government created conservation programs and encouraged farmers into rearing the said animals. Satisfying the country's need for affordable animal protein, while maintaining the local animal genetic resource is a great challenge that can be possibly addressed through intensification and creation of a systematic production approach led by the government and involves both the cooperation of smallholders and commercial farmers. Such challenge

is a crucial deciding factor for prioritizing certain breeds of livestock that can give the most benefit to the said industry. Therefore, a confident approach that could satisfy the said need without neglecting the importance of the native breeds as well as having the least impact on the environment can be a solution for this matter. The government had already made the first step, through its various livestock programs that are handled by the respective responsible agencies and with good management, along with the farmers' cooperation and acceptance, it is possible for the country to secure the said need and conserve the native animals.

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## REFERENCES

- Abanto, O.D.–Bueno, C.M.–Beltran, E.D. (2012): Characterization of carcass and meat of Philippine native pigs. Abstract, Retrieved on February 3, 2021 from <https://agris.fao.org/agris-search/search.do?recordID=PH2014000825>.
- Ajmone-Marsan, P.–Garcia, J.F.–Lenstra, J.A. (2010): On the origin of cattle: how aurochs became cattle and colonized the world. *Evolutionary Anthropology: Issues, News, and Reviews*, 19(4), 148-157. <https://doi.org/10.1002/evan.20267>.
- Akerman, J.A. Jr. (1982): *American Brahman: A History of the American Brahman*. American Brahman Breeder Association (ABBA).
- Alqaisi, O.–Al-Abri, M.–Al-Abri, A.–Al-Marzooqi, W. (2020): A comparison of milk production from Holstein Friesian and Jersey cattle breeds under hot climate of Oman. *Tropical animal health and production*. 52(3), 1503–1506. <https://doi.org/10.1007/s11250-019-02093-9>.
- Aquino, G.M.B.–Laude, R.P.–Jianlin, H.–Sevilla, C.S.–Hanotte, O. (2006): Genetic structure of selected cattle populations in the Philippines using microsatellites. *Philippine Journal of Veterinary and Animal Science*, 32(1), 1–9. Retrieved on February 10, 2021 from [https://www.researchgate.net/publication/282689775\\_Genetic\\_structure\\_of\\_selected\\_cattle\\_populations\\_in\\_the\\_Philippines\\_using\\_microsatellites](https://www.researchgate.net/publication/282689775_Genetic_structure_of_selected_cattle_populations_in_the_Philippines_using_microsatellites).
- American Boer Goat Association. Boer History. <https://abga.org/about-abga/history/>. Accessed on 22 December 2020.
- Amano, N.–Piper, P.J.–Hung, H.C.–Bellwood, P. (2013): Introduced domestic animals in the neolithic and metal age of the Philippines: evidence from Nagsabaran, Northern Luzon. *The Journal of Island and Coastal Archaeology*, 8(3), 317–335. [https://www.researchgate.net/publication/269354880\\_Introduced\\_Domestic\\_Animals\\_in\\_the\\_Neolithic\\_and\\_Metal\\_Age\\_of\\_the\\_Philippines\\_Evidence\\_From\\_Nagsabaran\\_Northern\\_Luzon](https://www.researchgate.net/publication/269354880_Introduced_Domestic_Animals_in_the_Neolithic_and_Metal_Age_of_the_Philippines_Evidence_From_Nagsabaran_Northern_Luzon).
- Arboleda, C.R. (1987): Animal genetic resources conservation and development in the Philippines, *Animal Production Technology Journal*, 3(2), 2–7.
- Arganosa, V.G.–Napoles, L.P.–Aquino, A.J. (1988): Comparative reproductive performance of purebred Pietrain swine and their crossbreds with Duroc, yorkshire and hampshire [Philippines]. Abstract, Retrieved on December 22, 2020 from <https://agris.fao.org/agris-search/search.do?recordID=PH8812494>.
- Baguio, S.S. (2017): R&D initiatives towards designing climate change resilient domesticated animal genetics in the Philippines. Retrieved on February 11, 2021 from [http://211-75-250-245.hinet-ip.hinet.net/FABRC/2017\\_CSGPAI/2017CSGPAI\\_p120-124.pdf](http://211-75-250-245.hinet-ip.hinet.net/FABRC/2017_CSGPAI/2017CSGPAI_p120-124.pdf).
- Bar Digest (2016): *Harnessing Philippine native animals through R&D*. Retrieved on February 11, 2020 from [https://www.bar.gov.ph/downloadables/digest/2016/BD\\_4thq%202016\\_final%20draft.pdf](https://www.bar.gov.ph/downloadables/digest/2016/BD_4thq%202016_final%20draft.pdf).
- Berman, A. (2011): Invited review: Are adaptations present to support dairy cattle productivity in warm climates? *Journal of dairy science*, 94 (5), 2147–2158. <https://doi.org/10.3168/jds.2010-3962>.
- Bollongino, R.–Burger, J.–Powell, A.–Mashkour, M.–Vigne, J.D.–Thomas, M.G. (2012): Modern taurine cattle descended from small number of near-eastern founders. *Molecular biology and evolution*, 29(9), 2101–2104. <https://doi.org/10.1093/molbev/mss092>.
- Bondoc, O. (1998): *Biodiversity of livestock and poultry genetic resources in the Philippines*. 1st ed. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. Los Baños, Laguna: IAS-CA/UPLB and PCARRD/DOST, Philippines, p. 141.
- Bondoc, O.–Del Rosario, N.A.–Manalili, L.L.G.–Cruz, E.M. (2018): Genetic and phenotypic trends in milk production traits of anglonubian goats from selected farms in the Philippines. On-line <http://pjvas.org/index.php/pjvas/article/view/208>.
- Bondoc, O.–Dominguez, J.M.D.S.A.–Vega, R.–Sandoval, R.F.–Santiago, R.C. (2017): Farrowing and weaning performance of black tiaong and kalinga native pig breeds at a conservation farm, Philippines. *Philippine Journal of Veterinary and Animal Science*. 43(1), 22-32. On-line <https://www.pjvas.org/index.php/pjvas/article/view/170/152>.
- Bondoc, O.L.–Dominguez, J.M.D.–Bueno, C.M.–Abanto, O.D. (2017): Evaluation of Pre-slaughter and Slaughter Data from Lechon-size Black Tiaong and Kalinga Native Pigs (Organic Farm) and Landrace, Large White and their F 1 Crosses (Conventional Farm). *Philippine Journal of Science*. 146 (4), 411–423. On-line [https://philjournalsci.dost.gov.ph/images/pdf/pjs\\_pdf/vol146no4/evaluation\\_of\\_preSlaughter\\_and\\_Slaughter\\_data\\_from\\_lechon-size\\_native\\_pigs.pdf](https://philjournalsci.dost.gov.ph/images/pdf/pjs_pdf/vol146no4/evaluation_of_preSlaughter_and_Slaughter_data_from_lechon-size_native_pigs.pdf).
- Bondoc, O.L.–Garcia, B.R.–Beltran, E.D.–Rapusas, M.–Gomez, B.C. (2002): Characteristics of Philippine native goats (*Capra hircus* Linn.). *The Philippine Agriculturist*, 85, 406-413. Retrieved on December 10, 2020 from <https://agris.fao.org/agris-search/search.do?recordID=PH2003000720>
- Borghese, A. (2005) *Buffalo Production and Research*. Food and Agriculture Organization of the United Nations. <http://www.fao.org/3/ah847e/ah847e00.pdf>. Accessed 15 December 2020.
- Boro, P.–Saharia, J.–Bharali, D.–Sarma, M.–Sonowal, M.–Brahma, J. (2020): Productive and reproductive performances of Murrah buffalo cows: A review. *Journal of Entomology and Zoology Studies*. 8(2), 290-293. On-line <https://www.entomoljournal.com/archives/2020/vol8issue2/PartF/8-2-22-413.pdf>.
- Boyles, R.–Schutz, E.–de Leon, J. (2016): *Bubalus mindorensis*. The I.U.C.N. Red List of Threatened Species 2016: e.T3127A50737640. Retrieved on December 27, 2020 from <https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T3127A50737640.en>.
- Breeds of Livestock. Breeds of Livestock-Goats: Boer. <http://afs.okstate.edu/breeds/goats/boer/index.html/>. Accessed 22 December 2020.
- Brion, A.C.B. (2016): A "one health approach" for Philippine native pigs. Retrieved on February 3, 2021 from <https://www.bar.gov.ph/index.php/digest-home/6237-a-one-health-approach-for-philippine-native-pigs>.
- British Goat Society. Anglo-Nubian. <https://www.britishtgoatsociety.com/about-us/breeds/anglo-nubian/>. Accessed 22 December 2020.
- C.A.B.I. *Bubalus bubalis* (Asian water buffalo). Retrieved on March 19, 2021 from <https://www.cabi.org/isc/datasheet/90762>.
- Caliebe, A.–Nebel, A.–Makarewicz, C.–Krawczak, M.–Krause-Kyora, B. (2017): Insights into early pig domestication provided by ancient DNA analysis. *Scientific reports*, 7, 44550. <https://doi.org/10.1038/srep44550>.



- Cameron, N.D. (2010): Comparison of Duroc and British Landrace pigs and the estimation of genetic and phenotypic parameters for growth and carcass traits. *Abstract, Animal Science*, 50(1), 141–153. <https://doi.org/10.1017/S0003356100004542>.
- Casey, N.H.–Van Niekerk, W.A. (1988): The Boer goat. I. Origin, adaptability, performance testing, reproduction and milk production. *Small Ruminant Research*. 1(3), 291–302. [https://doi.org/10.1016/0921-4488\(88\)90056-9](https://doi.org/10.1016/0921-4488(88)90056-9).
- Coffey, E.L.–Horan, B.–Evans, R.D.–Berry, D.P. (2016): Milk production and fertility performance of Holstein, Friesian, and Jersey purebred cows and their respective crosses in seasonal-calving commercial farms. *Journal of dairy science*. 99(7), 5681–5689. <https://doi.org/10.3168/jds.2015-10530>.
- Cutrer, R. (2020): A brief history of American Brahman in the United States. Retrieved on December 20, 2020 from <https://brcutrer.com/a-brief-history-of-brahman-in-the-united-states/>.
- DA. [Department of Agriculture]. USPL480: Goat Production Project for Accelerated Hunger Mitigation Program (Goat Importation). <https://www.da.gov.ph/wp-content/uploads/2017/11/IB-068-17-Terms-of-Reference.pdf>. Accessed 15 December 2020.
- D.A.-B.A.I. [Department of Agriculture – Bureau of Animal Industry]. (2021): List of Registered Livestock farms. Unpublished data.
- Dela Cruz, R.T. (2016): Exploring the Money-Making Potentials of Meat and Skin from Native Pig. Retrieved on March 18, 2021 from <https://www.bar.gov.ph/index.php/digest-home/digest-archives/773-2016-4th-quarter/5894-harnessing-philippine-native-animals-through-r-d>.
- De los Santos, E.B. (1987): Comparative evaluation of the work ability of the Philippine Carabao and its crosses with Murrah (F1) and Nili-Ravi (F1) in terms of physiological responses. Master Thesis, University of the Philippines, College, Laguna, Philippines, 1987.
- DOST-PCARRD [Department of Science and Technology-Philippine Council for Agriculture, Forestry and Natural Resources Research and Development]. (2016): Philippine pork to the world. Retrieved on February 3, 2021 from <http://www.pcaarrd.dost.gov.ph/home/portal/index.php/quick-information-dispatch/2681-philippine-pork-to-the-world#:~:text=Swine%20production%20plays%20a%20major,and%20number%20of%20breeding%20sows>
- Doydora, M.M.–Salces, A.J.–Oliveros, M.C.R.–Geromo, R.B.–Migrino, A.M.C.V.–Elumba, J.A. (2014): Carcass and sensory characteristics of different breeds of beef cattle raised in a ranching operation. *Abstract, Philippine Journal of Veterinary and Animal Science*, 40 (2), On-line <https://ejournals.ph/article.php?id=9883>.
- DPI-NSW (2020a): Goat breeds: Anglo-Nubian. <https://www.dpi.nsw.gov.au/animals-and-livestock/goats/breeds/anglo-nubian>. Accessed on 23 December 2020.
- DPI-NSW (2020b): Goat breeds: Toggenburg <https://www.dpi.nsw.gov.au/animals-and-livestock/goats/breeds/toggenburg>. Accessed on 23 December 2020.
- F.A.O. [Food and Agriculture Organization]. (2003): Status of the Philippines' Animal genetic resources (A Country Report). Retrieved on December 10, 2020 from <http://www.fao.org/3/a1250e/annexes/CountryReports/Philippines.pdf>
- F.A.O. [Food and Agriculture Organization]. (2007): State of the art in the management of animal genetic resources: Methods of Characterization. Retrieved on February 18, 2021 from <http://www.fao.org/3/a1250e/a1250e16.pdf>.
- F.A.O. [Food and Agriculture Organization]. (2013): The state of the worlds biodiversity for food and agriculture (Country report: Philippines). Retrieved on February 18, 2021 from <http://www.fao.org/3/i4787e/i4787e55.pdf>.
- Flores, E.B. (2017): Phenotypic trend and estimates of genetic parameters for growth traits of Philippine swamp buffaloes in a nucleus herd, Cagayan province, Philippines. *Philippine Journal of Veterinary and Animal Science*, 43(2), 67–72. On-line <https://www.pjvas.org/index.php/pjvas/article/view/180/161>.
- French Genetics. Goat breeds: Alpine. <http://en.france-genetique-elevage.org/Alpine,403.html>. Accessed on 23 December 2020.
- Galang, E.I.N. (2017): Climate Change Mitigation and Adaptation Proposal for the Philippine Livestock and Poultry. 10.13140/RG.2.2.22213.40165. Retrieved on December 10, 2020 from <https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.13140%2FRG.2.2.22213.40165>
- Garillo, E.P. (1986): Comparative draftability of carabaos and crossbred steers (M.P. x P.C.) under wet and dry land tillage operations. Master Thesis, Central Luzon State University, Muñoz, Nueva Ecija, Philippines, 1986
- Goats Extension. (2019): Goat Breeds Saanen. <https://goats.extension.org/goat-breeds-saanen/>. Accessed on 23 December 2020.
- Gotoh, T.–Nishimura, T.–Kuchida, K.–Mannen, H. (2018): The Japanese Wagyu beef industry: current situation and future prospects – A review. *Asian-Australasian journal of animal sciences*, 31(7), 933–950. <https://doi.org/10.5713/ajas.18.0333>.
- Groves, C.P. (2008): Taxonomy of wild pigs (*Sus*) of the Philippines. *Zoological Journal of the Linnean Society*, 120(2), 163–191. <https://doi.org/10.1111/j.1096-3642.1997.tb01277.x>
- Hagan, J.K.–Etim, N.N. (2019): The effects of breed, season and parity on the reproductive performance of pigs reared under hot and humid environments. *Tropical animal health and production*, 51(2), 411–418. <https://doi.org/10.1007/s11250-018-1705-5>.
- Hermosura, S.R.–Mordeno, R.A. (1982): Comparative performance of Philippine-born Holstein and Jersey cows at Baguio dairy farm with reference to milk production, reproductive efficiency and heat tolerance: Summary report. Retrieved on December 18, 2020 from <https://agris.fao.org/agris-search/search.do?recordID=XB8310695>.
- Huffman, B. (2016): Tamaraw (*Bubalus mendorensis*). Retrieved on December 20, 2020 from [http://www.ultimateungulate.com/Artiodactyla/Bubalus\\_mindorensisFull.html](http://www.ultimateungulate.com/Artiodactyla/Bubalus_mindorensisFull.html)
- Icamina, P.M. (2019): Going native: Genetic R&D to improve local pig breeding lines. *AGRIMAG, Monthly Agriculture*. Retrieved on February 9, 2021 from <https://www.agriculture.com.ph/2019/02/23/going-native-genetic-rd-to-improve-local-pig-breeding-lines#:~:text=For%20all%20its%20importance%20in,sway%20back%20and%20sagging%20belly>.
- Khanm, R.–Akhtar, S. (1999): Production Characteristics of Nili-Ravi Buffaloes. *Asian-Australasian Journal of Animal Sciences*, 12(1), 56-60. <https://doi.org/10.5713/ajas.1999.56>
- Legacy.senate.gov.ph. (2015): Senate Bill 2674. <http://legacy.senate.gov.ph/lisdata/2068617790!.pdf>, Accessed on 2 February 2021.



- Lesaca, P.R.A. (2016): Harnessing Philippine Native Animals Through R&D. *Bar Digest*, 18. 4. Retrieved on January 3, 2021 from [https://www.bar.gov.ph/index.php/digest-home/digest-archives/773-2016-4th-quarter/5894-harnessing-philippine-native-animals-through-r-d#:~:text=Creation%20of%20the%20Philippine%20Native%20Animals%20Development%20\(PNAD\)%20Program&text=The%20PNAD%20seeks%20to%20conserve,rural%20poverty%20in%20using%20them](https://www.bar.gov.ph/index.php/digest-home/digest-archives/773-2016-4th-quarter/5894-harnessing-philippine-native-animals-through-r-d#:~:text=Creation%20of%20the%20Philippine%20Native%20Animals%20Development%20(PNAD)%20Program&text=The%20PNAD%20seeks%20to%20conserve,rural%20poverty%20in%20using%20them).
- Liang, J.B.–Paengkoum, P. (2019): Current status, challenges and the way forward for dairy goat production in Asia - conference summary of dairy goats in Asia. *Asian-Australasian journal of animal sciences*, 32 (8), 1233–1243. <https://doi.org/10.5713/ajas.19.0272>.
- Malvaz, R.D. (2019): Phenotypic Characterization of Various Goats Gene Pool (*Capra hircus*) in Oriental Mindoro. *Journal of Environmental Treatment Techniques*, 1185–1190. Retrieved on February 9, 2021 from [http://www.jett.dormaj.com/docs/Volume7/special%20issue/Phenotypic%20Characterization%20of%20Various%20Goats%20Gene%20Pool%20\(Capra%20hircus\)%20in%20Oriental%20Mindoro.pdf](http://www.jett.dormaj.com/docs/Volume7/special%20issue/Phenotypic%20Characterization%20of%20Various%20Goats%20Gene%20Pool%20(Capra%20hircus)%20in%20Oriental%20Mindoro.pdf).
- MinDanews (2015): Department of Agriculture's mini cow project to study another breed. Retrieved on December 10, 2020 from <https://www.mindanews.com/top-stories/2015/03/das-mini-cow-project-to-study-another-breed/>.
- Momongan, V.G.–Sarabia, A.S.–Obsioma, A.R.–Capitan, S.S.–Roxas, N.P.–Palad, O.A.–Dela Pena, E.C. (1991): Reproductive Performance and Milk Production of Philippine Carabaos and Phil-Murrah Crossbreds in Simulated Smallholder Farmers' Environment. *Proceedings of the Australian Center for International Agricultural Research*, Canberra Australia, 1991; Lynch, P.W.; Goanna Print Pty Ltd, Canberra, Australia. Retrieved on March 19, 2021 from [https://aciar.gov.au/sites/default/files/legacy/node/2262/pr34\\_pdf\\_21126.pdf](https://aciar.gov.au/sites/default/files/legacy/node/2262/pr34_pdf_21126.pdf).
- Nayga, J.–Valdez, E.–Andres, M.–Estrada, B.–Lopez, E.–Tamayo, R.–Balbin, A. (2015): 'Slaughter and Carcass Characterization, and Sensory Qualities of Native, Pure, and Upgraded Breeds of Goat Raised in the Philippines'. *World Academy of Science, Engineering and Technology, Open Science Index 106, International Journal of Nutrition and Food Engineering*, 9(10), 1134–1137. <https://doi.org/10.5281/zenodo.1327258>.
- N.D.A. [National Dairy Authority]. Breeding Services. Retrieved on December 10, 2020 from <https://nda.da.gov.ph/index.php/en/services/breeding-services>.
- NZDL [The New Zealand Digital Library]. Backyard carabao raising for the draft and milk. Retrieved on March 19, 2021 from <http://www.nzdl.org/cgi-bin/library?e=d-00000-00---off-0hdl-00-0---0-10-0--0---0direct-10---4-----0-11-11-en-50---20-about---00-0-1-00-0-4---0-0-11-10-OutfZz-8-10&cl=CL2.15.4&d=HASHdef7cdefa42f3a2a3a9a85.7.9&gt=1>.
- Oh, J.D.–Grace, R.–Cacho, C.–Choi, J.–Seo, J.–Song, K.D.–Vega, R.–Santiago, R.–Octura, J.E.–Octura, R.–Kim, S.W.–Kim, C.–Kim, S.–Kong, H.–Lee, H.–Cho, B. (2014): Genetic Analysis of Philippine Native Pigs (*Sus scrofa* L.) Using Microsatellite Loci. *Philippine Journal Science*, 143 (1), 87–94. On-line [https://philjournalsci.dost.gov.ph/images/pdf/pjs\\_pdf/vol143no1/pdf/genetic\\_analysis\\_of\\_Phil\\_native\\_pigs.pdf](https://philjournalsci.dost.gov.ph/images/pdf/pjs_pdf/vol143no1/pdf/genetic_analysis_of_Phil_native_pigs.pdf).
- Olson, K.M.–Cassell, B.G.–McAllister, A.J.–Washburn, S.P. (2009): Dystocia, stillbirth, gestation length, and birth weight in Holstein, Jersey, and reciprocal crosses from a planned experiment. *Journal of dairy science*, 92 (12), 6167–6175. <https://doi.org/10.3168/jds.2009-2260>.
- PCARRD-DOST. Native pig information system. <https://pabis.pcaarrd.dost.gov.ph/nativepigs/>. Accessed on 11 February 2021.
- P.C.C. [Philippine Carabao Center] (2015): P.C.C. improving native Carabao breed for greater productivity. Retrieved on December 23, 2020 from <https://www.pcc.gov.ph/pcc-improving-native-carabao-breed-for-greater-productivity/>.
- P.C.C. [Philippine Carabao Center] (2020): The Carabao as a commodity. Retrieved on December 23, 2020 from <https://www.pcc.gov.ph/the-carabao-as-a-commodity/>.
- P.C.C. [Philippine Carabao Center] (2018): Annual report. Retrieved on January 10, 2021 from <https://www.pcc.gov.ph/wp-content/uploads/2019/09/PCC-Annual-Report-2018-KMPadre-for-uploading-pdf-min.pdf>.
- P.I.C. [Pig Improvement Company] (2020): Boars. <https://www.pic.com/services/boars/>. Accessed on 10 December 2020.
- P.S.A. [Philippine Statistics Authority] (2012): Special Report on Livestock and Poultry in the Philippines. Retrieved on March 22, 2021 from <https://psa.gov.ph/content/census-agriculture-and-fisheries-caf>.
- P.S.A. [Philippine Statistics Authority] (2015): 2012 National Census in Agriculture. Quezon City, Philippines: Philippine Statistics Authority.
- P.S.A. [Philippine Statistics Authority] (2016): 2016 Annual Survey of Philippine Business and Industry (ASPBI) – Agriculture, Forestry and Fishing Sector with Total Employment of 20 and Over: Preliminary Results. Retrieved on February 9, 2021 from <https://psa.gov.ph/content/2016-annual-survey-philippine-business-and-industry-aspbi-agriculture-forestry-and-fishing>.
- P.S.A. [Philippine Statistics Authority] (2020a): 2015–2019 Livestock and Poultry Statistics in the Philippines. [https://psa.gov.ph/sites/default/files/L\\_P%20stat%20of%20the%20Phil\\_signed.pdf](https://psa.gov.ph/sites/default/files/L_P%20stat%20of%20the%20Phil_signed.pdf). Accessed on 10 December 2020.
- P.S.A. [Philippine Statistics Authority] (2020b): Industry Performance Report. <https://psa.gov.ph/livestock-poultry-ips/inventory>. Accessed on 5 January 2021.
- Parawan, O.–Ovalo, A.–Curativo, V.–Hipol, S. (1987): Study on the reproduction and production performance of Philippine Native goat and 50%, 75% Philippine Native x Anglo Nubian crossbreds at village conditions. Abstract. On line <https://agris.fao.org/agris-search/search.do?recordID=PH8810546>.
- Piñol, E.F. (2016): Philippine Agriculture: Today and the Future. Retrieved on January 2, 2021 from [https://www.da.gov.ph/wp-content/uploads/2016/12/The\\_Philippine\\_Agriculture\\_Today\\_and\\_the\\_Future.pdf](https://www.da.gov.ph/wp-content/uploads/2016/12/The_Philippine_Agriculture_Today_and_the_Future.pdf).
- Piper, P.–Hung Hung, H.–Campos, F.–Belwood, P.–Santiago, R. (2009): A 4000 year-old introduction of domestic pigs into the Philippine archipelago: Implication for understanding routes of human migration through Island Southeast Asia and Wallacea. *Antiquity*, 83(321), 687–695. Electronic paper, retrieved on February 3, 2021 from <https://www.scopus.com/record/display.uri?eid=2-s2.0-77949818125&origin=inward&txGid=17ef9508551584b1cd66fa50f8f97066>.
- Pitt, D.–Sevane, N.–Nicolazzi, E.L.–MacHugh, D.E.–Park, S.–Colli, L.–Martinez, R.–Bruford, M.W.–Orozco-terWengel, P. (2018): Domestication of cattle: Two or three events?. *Evolutionary applications*, 12(1), 123–136. <https://doi.org/10.1111/eva.12674>.



- Provido, N.T. (2018): Reshaping Mindanao's cattle industry. Retrieved on December 15, 20 from <https://www.agriculture.com.ph/2018/12/01/reshaping-mindanaos-cattle-industry/>.
- Sanchez, M.J. (2020): Gross output value of livestock industry Philippines 2014–2019. Retrieved on December 10, 2020 from <https://www.statista.com/statistics/1171577/philippines-gross-output-value-livestock-industry/>
- Santiago, R. (2010): Strategies and Prospect of Native pig breeding in the Philippines. Retrieved on December 15, 2020 from [https://www.angrin.tlri.gov.tw/meeting/2017TwPhi/2017TaiPhi\\_p47-53.pdf](https://www.angrin.tlri.gov.tw/meeting/2017TwPhi/2017TaiPhi_p47-53.pdf).
- Sheresta, N.P. (1992): Genetic evaluation of Philippine Carabao, Murrah Buffalo, and the F1 Hybrids (M.B. x P.C. and Nili-Ravi x P.C.). PhD Thesis, Institute of Animal Science, University of the Philippines, Los Baños, Laguna, Philippines, 1992.
- Subsuban, C.P.–Cambel, I.H.–Cuico, E.T. (1990): Distinct characteristics of the Dadiangas strain goats and their upgrades: Summary report. Retrieved on December 18, 2020 from <https://agris.fao.org/agris-search/search.do?recordID=PH9010638>.
- T.C.S. [The cattle site] (2020a): Cattle breeds: Simmental. <https://www.thecattlesite.com/breeds/beef/17/simmental/>. Accessed on 21 December 2020.
- T.C.S. [The cattle site] (2020b): Cattle breeds: Hereford. <https://www.thecattlesite.com/breeds/beef/14/hereford/>. Accessed on 21 December 2020.
- T.C.S. [The cattle site] (2020c): Cattle breeds: Wagyu. <https://www.thecattlesite.com/breeds/beef/49/wagyu/>. Accessed on 21 December 2020.
- T.C.S. [The cattle site] (2020d): Cattle breeds: Holstein. <https://www.thecattlesite.com/breeds/dairy/22/holstein/>. Accessed on 21 December 2020.
- T.C.S. [The cattle site] (2020e): Cattle breeds: Sahiwal. <https://www.thecattlesite.com/breeds/dairy/96/sahiwal/>. Accessed on 21 December 2020.
- T.C.S. [The cattle site] (2020f): Cattle breeds: Simbrah. <https://www.thecattlesite.com/breeds/beef/90/simbrah/>. Accessed on 21 December 2020.
- T.P.S. [The pig site] (2020a): Philippine Native. <https://www.thepigsite.com/breeds/philippine-native>. Accessed on 18 December 2020.
- T.P.S. [The pig site]: (2020b): Pig Breeds: Duroc. <https://www.thepigsite.com/focus/advertiser/3656/the-different-breeds-of-swine-duroc-duroc-pig-breed-duroc-gilts-sows-and-boars>. Accessed on 20 December 2020.
- T.P.S. [The pig site] (2020c): Pig Breeds: Landrace. <https://www.thepigsite.com/breeds/american-landrace>. Accessed on 20 December 2020.
- T.P.S. [The pig site] (2020d): Pig breeds: Large White. <https://www.thepigsite.com/focus/advertiser/3661/the-different-breeds-of-swine-large-white-large-white-pig-breed-large-white-gilts-sows-and-boars>. Accessed on 20 December 2020.
- T.P.S. [The pig site] (2020e): Pig breeds: Pietrain. <https://www.thepigsite.com/focus/advertiser/3665/the-different-breeds-of-swine-pietrain-pietrain-pig-breed-pietrain-gilts-sows-and-boars>. Accessed on 20 December 2020.
- Tablizo, R.A.–Araneta, G. (1987): The growth performance of pure breed French alpine and upgrade alpine goats from birth to weaning age. Abstract, On-line <https://agris.fao.org/agris-search/search.do?recordID=PH871119088>.
- Takeshima, S.N.–Miyasaka, T.–Polat, M.–Kikuya, M.–Matsumoto, Y.–Mingala, C.N.–Villanueva, M.A.–Salces, A.J.–Onuma, M.–Aida, Y. (2014): The great diversity of major histocompatibility complex class II genes in Philippine native cattle. *Meta gene*, 2, 176–190. <https://doi.org/10.1016/j.mgene.2013.12.005>
- The Pork Production Committee (2004): The Philippines recommends for pork production. Los Baños, Laguna: PCAARRD/DOST-PFIZER, Inc., 2005. 131p.-(Philippine Recommends Series no.13-B. Retrieved on February 9, 2021 from [http://scinet.dost.gov.ph/union/Downloads/STII-B-00005\\_173704.pdf](http://scinet.dost.gov.ph/union/Downloads/STII-B-00005_173704.pdf).
- Thiengpimol, P.–Tappreang, S.–Onarun, P. (2017): Reproductive Performance of Purebred and Crossbred Landrace and Large White Sows Raised under Thai Commercial Swine Herd. *Science & Technology Asia*, 22(2), 16–22. On-line <https://ph02.tci-thaijo.org/index.php/SciTechAsia/article/view/90997>.
- Villar, E.C.–Aglibut, F.B.–Castillo, L.S.–Sison, O.F. (1984): Performance of purebred native and grade goats raised in complete confinement at the Philippine Rural Life Center goat herd. Presented paper at the 20<sup>th</sup> PSAS Annual Convention, PICC Manila.
- Villegas, V.E.–Cruz, C.E. (1958): Dairy qualities of Philippine cows. *Philippine Agriculture*, 41(9), 495-498. On-line <https://agris.fao.org/agris-search/search.do?recordID=PH2002001301>.
- Wagyuinternational (2013): Wagyu around the world- Philippines. [http://www.wagyuinternational.com/global\\_Philippines.php](http://www.wagyuinternational.com/global_Philippines.php). Accessed on 26 December 2020.
- Wild Pig (2020): Philippine Warty Pig (*Sus philippensis*) <https://sites.google.com/site/wildpigspecialistgroup/home/Sus-philippensis>. Accessed on 18 December 2020.
- Zhang, Y.–Colli, L.–Barker, J. (2020): Asian water buffalo: domestication, history and genetics. *Animal genetics*, 51(2), 177–191. <https://doi.org/10.1111/age.12911>.

