
**DISPLAY OF LOCAL PIG REPRODUCTION IN EAST NUSA TENGGARA,
INDONESIA**

Jefirstson Richset Riwukore¹ and Fellyanus Habaora²

¹ Lecturer of Management Graduate Program of Indo Global Mandiri University Jalan Jenderal Sudirman No.629
Palembang, Postal Code 30129

² Post Graduate Progame Animal Production and Technology, Faculty of Animal Sciences, Bogor Agricultural
University

<http://doi.org/10.35410/IJAEB.2019.223233>

ABSTRACT

A research has been conducted on the appearance of local pig reproduction in East Nusa Tenggara province for two month, ie January-February 2019 using secondary desk research data techniques, which include: profiles of local pig farms and local pig reproductive performance. The conclusions of the research are: the reproductive performance of local pigs in East Nusa Tenggara province is still low which emerges from puberty until the age of first birth, birth weight, birth weight of piglets, number of weaned piglets, quite high mortality rate and interval giving birth long enough. In general, increasing production and reproduction of local pigs need to pay attention to aspects of breeding, feeding and management

Keywords: local pig, reproduction

1. INTRODUCTION

Pigs have a comparative advantage compared to other livestock, because:

1. Pigs have a contribution as providers of animal protein needs for ideal consumption of protein needs, namely: for the age of children (1,5 grams of protein / kilogram body weight / day), adolescence (1,0 gram protein / kilogram body weight / day), and adult age (0,8 gram protein / kilogram body weight / day);
2. Pigs are omnivorous monogastric animals because they are able to convert all food ingredients into meat and fat, including changing household food products, agricultural products, factories, and so on, because to produce 1 kilogram of pig's body weight needed 3,5 kilograms of feed;
3. Pigs are prolific animals where littersize reaches 7 to 12 piglets in each birth which can be harvested twice a year for 1 year;
4. Pigs produce higher carcasses (65-80% of body weight), compared to cattle (50-60% of body weight), sheep and goats (45-55% of body weight), and buffaloes (38% of body weight);
5. Pigs have a higher fat composition and lower water composition so that the energy value is higher;

6. Pigs according to various literature report that these animals are more adaptable to the system of using cage equipment such as automatic drinking and eating, so that labor costs can be saved (Franzke et. al. 2018; Ivic et.al. 2017; Salea et al. 2018; Skorput et.al. 2018).

The increase in pig production in Indonesia generally prioritizes the maintenance of ex-imported pigs because it is more efficient than local pig livestock (Dewantoro et al.2015). Local pigs productivity is still low because it has not received serious attention in its management, due to not providing maximum production and reproductive performance. Soewandi et.al. (2013) reported that the daily weight gain of local pigs was only 0.14 kg, while for imported pigs (Landrace type) it could reach 0,24 kg. The low productivity of local pigs causes farmers to switch to raising imported pigs.

One aspect that affects livestock performance is the reproductive performance of the livestock itself. The rate of increase in livestock population will be faster if the reproductive efficiency is good, and / or the number of reproductive disorders is low. Abah et.al. (2019) states that production performance has a close relationship to reproductive performance, and vice versa. Reproductive performance (parent condition when pregnant, lactation period, calving interval, litter size from born piglets to weaning) which is less maximal has an impact on raising the livestock weight which is not optimal. Sinha et.al. (2015) states that the high and low reproductive efficiency of livestock is determined by the conception rate, calving interval, service period, service per conception, and calving rate.

Based on the description above, the development of local pigs needs to be done to support the contribution of pigs as one of the livestock that has a comparative advantage in the supply of meat. The potential for developing pig farms in the province of East Nusa Tenggara, Indonesia, is more promising because it has a high population followed by high rates of slaughter of pigs. The pig population in East Nusa Tenggara reached 1,812,499, which was higher than the population of beef cattle (899,534), buffaloes (141,075), horses (111,047), goats (626,431), and sheep (65,421 tail). Pork meat production reached 32,726,100 kg / year from the number of slaughtered 158,672 pigs in Animal Slaughterhouses, and as many as 634,688 pigs cut outside Animal Slaughterhouses (NTT Statistics 2016). This data is quite promising in increasing the profitability of pig farms. However, the statistical data is only oriented to the aspect of production, while the type of pig is eliminated.

The information above is an empirical material in increasing the productivity of local pigs according to the Strategic Plan of the Directorate General of Animal Husbandry and Animal Health since 2014, namely an increase in pig population (local and ex-import) of 1.15% per year. Reproductive aspects are important in terms of increasing pig population. Therefore, it is necessary to conduct a study of the profile of the reproductive aspects of local pigs in the Province of East Nusa Tenggara, Indonesia. Then followed by a development strategy based on information on the reproductive aspects of local pigs obtained.

2. METHODS

The study was conducted for 2 (two) month, namely January-February 2019, in the Province of East Nusa Tenggara, Indonesia, using desk research techniques, namely the technique of collecting data documents needed in conducting research using secondary data, which includes: profile of local pig farms and local pig reproduction performance. The data that has been obtained, then processed by descriptive method, is a method used to understand a phenomenon in a natural context by prioritizing the explanation of data sources and facts in the form of narration and numbers.

3. RESULTS AND DISCUSSION

1. Profile of Local Pig Farms in East Nusa Tenggara Province

Local pigs in the province of East Nusa Tenggara come from wild pigs / wild boar (*Sus verrucosus*) which are then domesticated (*Sus domesticus*) with body characteristics, namely: black or black striped, black top and white; small head, pointed snout with short ears, and standing tall; the stomach almost hits the ground, because it has a long, weak backbone and short legs. Local pigs that are common in East Nusa Tenggara are Balinese pigs, Sumba pigs, Krawang pigs, Nias pigs, and heterogeneous offspring. Local pigs have a role in the socio-cultural life of the local community.

Local pigs in East Nusa Tenggara Province, 85% are traditionally maintained, and also semi-intensive. Then as many as 85% of farmers raise their pig livestock in cages whose floors are from the ground, 5% of farmers use the stage cage, 6% of farmers raise pigs in their home kitchens, and 4% of farmers, tethering pigs with ropes under trees around the house grounds.

Production capability for adult local pigs can reach 24.5-31.6 kg / pig tail, with a long maintenance period of 3-4 years without taking into account production costs. The types of feed commonly given to local pigs in the province of East Nusa Tenggara are corn, bran, coconut pulp, putak, and vegetables, as well as household food waste. Putak is a commonly used feed. Putak is the contents of the gawang tree (*Corypha gebanga*), which is a palm plant that is high in carbohydrate content, and is predominantly grown on the island of Timor, East Nusa Tenggara Indonesia.

Local pigs in East Nusa Tenggara generally suffer from prolonged mineral deficiency, and lack of amino acids, which are the main contributing factors to the slow growth and cause of death of pigs. In addition, the local pig population has decreased due to the attack of the Hog cholera epidemic over the past 5 years.

2. Local Pig Reproduction Performance in East Nusa Tenggara

Reproduction is a physiological bodily function that is not vital to that life, but is important for the continuation of the descendants of an animal species or nation. Reproduction can take place when the animal reaches puberty. Puberty in male animals is characterized by the desire to mate, the ability to mate, and produce sperm. While female animals are characterized by estrus and

ovulation. The accumulation of the processes that occur shows reproductive performance of livestock, namely the ability of living beings to produce new individuals (Tur 2013; Abah et.al. 2019).

Age of the local sows when giving birth first

Age of the local sows when giving birth first in the East Nusa Tenggara province at an average of 13,76 months. This data shows the Age local sows pig when giving birth first is longer than the ideal the age of sows when giving birth first, which is 11-13 months. This is due to the lack of attention and knowledge of farmers in the management of livestock marriage. Likewise, the feed provided is inadequate in quality and quantity so that the process of pig growth is hampered, and is followed by the slow pace of reaching the sex adult (puberty). The maintenance system of local pigs that are still traditional causes the breeding pattern of livestock not to be controlled so that inbreeding events continue to occur. In addition, the castration system for male pigs before the age of 5-6 months causes the available male to be very limited, and / or available males not of high quality.

Adolescent sows should give birth first at the age of 11-13 months, so that when the sows give birth first when the condition reaches the adult body. The disadvantages of local sows that are too early to mate are: local sows will remain small because the sows growth is disrupted; local piglets born with small and weak bodies, are not resistant to disease disorders due to lack of adequate nutrition from sow milks; the low production of milk from sows is still limited; and local sows suffer from childbirth because the hip bones are still narrow, and have not fully grown.

Adolescent pigs (gilt) that are experiencing estrus, should not be mated when the first estrus, but when experiencing estrus to the third or fourth. The gilt pig that was mated when the first estrus caused a small litter size. Likewise, if mated at the ideal age, sows will live longer and produce more children during their lifetime.

Littersize

Littersize is the number of piglets born in one birth period (Tur 2013; Sinha et.al. 2015). The factor that affects litter size is the type pig, the sows condition when mated, and the males. Then other factors that affect the low litter size are hormonal abnormalities, uterine infections and feed. Furthermore, Sows who are too fat or too thin tend to produce fewer living piglets.

Littersize from local sows in East Nusa Tenggara province on an average of 5.68 piglets per birth. Young sows produce litter size that is larger than gilts. The more often sows give birth, the higher the litter size. The peak of the litter size large increase occurs in the fifth to seventh births, then decreases again. Increasing the embryonal death rate may be a large decrease in litter size in older sows.

Birth Weight

Birth weight is determined by weighing the piglets immediately after birth until 24 hours of age. Birth weight of local piglets in East Nusa Tenggara at an average of 0.34 kg. This birth weight is normal for the size of the local pig type, especially which the first time to breed in dry tropical conditions. Abah (2019) states that the birth weight of a piglet at birth is very dependent on the body weight of sows and litter size. The higher the sows' body weight, the higher the birth weight of newborn piglets. The higher the litter size per birth period, the smaller the birth weight of the newborn piglets. Wientjes et.al. (2013) states that the ideal piglet birth weight at birth is 0,40 kg which is influenced by feed factors, heredity, and the number of piglets in the womb.

Sex Ratio

Sex ratio is a comparison of the number of male and sows, or gilt that are ready to be mated. The sex ratio of male to local sows in the province of East Nusa Tenggara was 1: 1.26. This sex ratio is considered to be good reproduction because the opportunity to mate from sows is easier, but economically less profitable. The local pig sex ratio in the province of East Nusa Tenggara is still difficult to know with certainty because marriage is naturally, it is difficult to control. In addition, the males used are piglets that have been weaned with a range of ages between 4-6 months so there is a high likelihood of inbreeding, and the male is not necessarily of good quality.

Weaning Piglets

Weaning piglets is an activity of separating piglets from sows which is done at less than 8 weeks of age, specifically for intensive farming systems. Weaning piglets earlier makes sows not lose weight, cycles of piglets are born faster, and feed for sows will be relatively small, because they do not need additional feed to be converted into milk (Koketsu et.al. 2017; Skorput et.al.2018).

The average number of local piglets weaned from sows is 3.94 piglets. Factors that affect the speedy pace of weaning piglets include: litter size, piglet mortality rates, body condition sows, and farmer management factors themselves. Weaning piglets is generally done when the piglets are 8 to 10 weeks old, because after 8 weeks of age, the production of milk decreases, so the chances of sows can give birth twice a year. Faster weaning will be beneficial in saving sows feed, and preventing transmission of infectious diseases from sows to piglets (Sosroadmijojo and Soeradji 1984). The average age of local piglets in the province of East Nusa Tenggara, weaned at the age of 3-4 months under extensive (traditional) system conditions. Weaning like this if followed by economic calculations is very detrimental.

Local Piglets Mortality Rate

The high mortality of local piglets is influenced by environmental conditions when piglets are born, are unable to adapt to temperature and environmental conditions efficiently. Low environmental temperatures will cause death in piglets because their feathers are rare and have limited fat production (Machado et.al.2016; Franzke et.al.2018). Besides that, it is also influenced by the lack of continuous attention from farmers to cattle that are maintained. Cage

construction and sanitation need to be considered in order to avoid predatory disturbances (animals and humans), and feeding to pigs has not fulfilled the food requirements for sows who are breastfeeding or to piglets (Oelke et.al.2018; Salea et.al.2018).

The average mortality of piglets in East Nusa Tenggara Province reached 55.82%, which was caused by overtaken sows (10.07%), difficulties or death at birth (13.12%), deaths due to hunger or lack of milk from sows (9.43%), deaths from disease (16.41%), and deaths due to accidents or predators (6.79%). Thus the life expectancy of local piglets per birth is 44.18%. Piglet mortality can be reduced by improving maintenance management.

Intervals give birth to piglets

the birth interval of a piglet is the distance between the first birth and the second and subsequent births. The sows that runs out of breeding can be mated back 5-7 days after weaning the piglets, because the pigs will estrus again 3-10 days after the piglets are weaned. Taking into account the age at weaning, the length of pregnancy, and the first lust after weaning, the birth interval can be achieved at 6 to 9 months or \pm 183 days (Tur et.al.2013; Wientjes et.al.2013; Abah et.al.2019).

The average interval for giving birth to a local piglet in the East Nusa Tenggara province is 9.98 months. Data from this study indicate that the birth interval is too long and not profitable because in a year, sows are only able to give birth once. The length of the interval for giving birth to a piglet is due to the length of time it takes to care for piglets because the management system is traditional. To shorten the interval of the birth of a piglet can be done by weaning the piglets early and a smaller sex ratio maintenance, as well as the provision of continuous, and good quality males.

3. Methods of Increasing Reproduction Status of Local Pigs

Improvement of Reproductive Status with Breeding

Breeding is an activity to marry a group of animals to upgrade certain characters, such as: growth, endurance, production, including reproduction. One way to improve the performance of local pigs is by artificial insemination techniques, livestock imports, and livestock culling. These three techniques have their own advantages and disadvantages, so the application needs to consider the existing existing conditions.

Artificial Insemination (AI) can enhance reproductive efficiency because sows get cement supply from superior stud without natural mating processes, superior quality of local stud can be maintained, save costs, avoid transmission of diseases, physiological from sows do not want to mate when estrus, and breeders will use an intensive maintenance system. Even though AI has been very satisfying and popular in the community, AI requires a long time or is difficult to record to reach the third and fourth generation. Steps to import livestock still need to be taken to replace the mothers whose production is bad. Improving livestock quality is more important than increasing population. By importing the productivity per tails increases so that the same volume

of livestock production can be produced by the number of livestock whose population is smaller. Whereas culling aims to get rid of unproductive livestock, and what is maintained is good livestock in terms of production, disease resistance, adaptation, maintenance, and digestion of feed.

Improvement of Reproduction Status with Feed Management

The reproductive status of livestock has a strong relationship with the intake of nutrients obtained for the body. Therefore it is necessary to pay attention to the pattern of nutritional needs during the period of growth and development of livestock.

Table 1. Recommendations on nutritional composition in accordance with standard needs of pigs in the Tropics

Nutrisi	Growing		Finishing	Gilt	Stud	Laktation
	10-20 kg	20-60 kg	61-90 kg	100-160 kg	140-200 kg	140-200 kg
PK (%)	18-20	16	14	14	14	15
E (Kcal)	3500	3500	3500	3100	3300	3300
Mineral	0,5	0,5	0,5	0,5	0,5	0,5

Source: Jenahat (2005)

Table 2. Substances contained in feed ingredients

Bahan Makanan	Water %	PK (%)	LK (%)	SK (%)	Ca %	P %	Energi (%)
Fish flour	8,5	53,3	6,5	1,5	10,5	5	49
Powder	8	33	1	0	1,3	0,9	68
Soybean meal	9,5	48,5	1	6,5	0,4	0,7	69
Coconut meal	9	19,5	7,5	13	0,2	0,5	73
Yellow corn	12	8,5	4,5	3	0,05	0,3	80
White corn	11,5	9	4,5	2	0,1	0,3	81
Katul No.1	10	13,5	16,5	7	0,15	1,9	60
Katul No.2	9,5	8	6	20,5	0,25	1,1	29
Leucaena leucocephala flour	8,5	19,5	3	11	1,9	0,2	45
Grit flour	-	-	-	-	24,5	-	-
Sugar	-	-	-	-	-	-	76

Source : AAK (2011).

Table 3. Type of feed ingredients according to each phase

Period/Age	Feed needs	Type of feed
Pig	1-2,5 kg + forage	Feed breed sows
Gilt		
- 3 month pregnancy	2 kg + forage	Feed breed sows
- finished pregnant	3 kg + forage	Feed lactation sows
Sows		

- 3 month	1,5 kg + forage	Feed breed
pregnancy	2,5 kg + forage	Feed lactation sows
- finished pregnancy		
Lactation sow*)		
- Gilt	2,5 kg + (0,25 kg/piglet)	Feed lactation sows
- Sows	2 kg + (0,25 kg/piglet)	
*) Gilt with 8 piglets = 2,5 kg + (8 x 0,25 kg) = 4,50 kg, feed intake of lactation sow + forage.		

Source: AAK (2011)

Table 4. Effect of Feed Consumption Levels on Puberty

	Treatment 1		Treatment 2	
	Adlibitum	Limited	Adlibitum	Limited
Puberty age (day)	173	194	159	170
Weight of puberty age (kg)	101	92	97	92

Source: Sihombing (1997)

Table 5. Effect of protein on age reaching puberty

Criteria	Protein 14%	Protein 16%
Body weight increase per day (kg)	0,63	0,54
Age reaching puberty (day)	160	179

Source: Sihombing (1997)

Table 6. The level of effect of the feed eaten during pregnancy on the feed eaten during lactation.

Feed consumption during pregnancy (kg/day)	0,9	1,4	1,9	2,4	3,0
Additional weight for pregnancy (kg)	5,9	30,3	51,2	62,8	74,4
Consumption of lactation feed(kg/day)	4,3	4,3	4,4	3,9	3,4
Changes in lactation weight (kg)	6,1	0,9	-4,4	-7,6	-8,5

Source: Sihombing (2006)

Table 7. The effect of limited feed feeding versus ad libitum during the first week after birth

	Limited*	Ad libitum
Banyak anak lahir	9,6	9,6
3 weeks old:		
- Many piglets	7,5	7,7
- Average body weight piglets (kg)	5,5	5,3
- The living (%)	79,2	81,4

Feed intake 0, 0,9, 1,8, 2,7, 3,6, 4,5 and 5,4 kg/day selama hari 1 hingga 7 setelah melahirkan.

Source: Sihombing (2006)

Tabel 8. Effect of feeding levels from weaning to remarriage of sows reproduction

	Feeding per day (kg) from weaning to mating again		
	1,8	2,7	3,6
Many sows	44,0	43,0	44,0
Time to reach estrus (day)	6,7	7,0	6,5
Conception rate (%)	93,0	95,0	86,0
Many piglets are born	10,8	11,4	10,6

Source: Sihombing (2006)

Improvement of Reproduction Status with Maintenance Management

In general, the local pig management system in the East Nusa Tenggara province is traditional or semi intensive. Intensive maintenance systems are rarely found in local pigs, but are often seen in local pig breeds, and other imported pig species. Improvement of reproductive status with maintenance management can be done with animal health management models and barn models.

The model for handling livestock health differs between stud, sows and gilt (before mating, pregnant, before giving birth, giving birth, lactating, until weaning). Stud that experience stress and disease can reduce the quality of semen and cause the fertility rate to decline 4-6 weeks after the stress period. Therefore, the stud must be sprayed with water to minimize the effects of stress. In addition, it is necessary to do stud vaccination once a year, but if the area is high in risk, it is important to do it every 6 months. Internal parasite prevention measures must also be taken. It would be nice if the stud is in the cage so that it gets serious attention from the farmer.

Sow or gilt need to be fed before mating to improve the rate of conception and many piglet born. Then it is necessary to treat the addition of high terramycin in the feed for 1-2 weeks after mating for sow or gilts. So or gilt that has been married, between 7-30 days of pregnancy (implantation period) do not be left stressed because it will reduce the number of fetuses that will implant so that piglet decreases at birth.

Sow who will give birth immediately transferred to the cage is born no later than 110 days after pregnancy. This action is carried out to reduce the death of piglets when the pregnancy is less than 114 days and also provides early adaptation to the environment. Then 7 days before delivery and within 7-21 days after giving birth, the sow ration must be fortified with antibacterial ingredients. The daily ration after delivery must be gradually increased to the maximum level on days 5 to 7. The rules for feeding determine a lot of milk, but it must be remembered that too much milk supply can cause piglets to diarrhea.

After the piglets are weaned, sow is separated from the piglet and transferred to the seedling cage and this action is carried out when the piglets are 4-6 weeks old. If weaning is done less than 4 weeks of age, the piglets are susceptible to stress and disease. If more than 6 weeks, the body weight decreases, lengthens the time to mate, and the piglet decreases per sows per year. The condition of the sow is good or prime when the child is weaned, usually estrus will arise within 3-6 days. Thin Sow often experiences slow, and unfertile estrus.

Improvement of Reproduction Status with Cage Management Systems

Pigs are classified as warm-blooded animals (homeotherms), namely physiological mechanisms to maintain the stability of the internal state of the body against conditions that are not suitable external environment. Pigs always try to achieve a homeostatic state through body heat balance, thermoregulation, biochemical balance sheets (water, electrolytes and carbon compounds), and balance of cardiovascular circulation. Therefore, the cage requirement must fulfill this.

The homeostatic state is determined by external factors, namely altitude, latitude of the earth, solar and earth radiation, relative temperature, and humidity of air, rainfall, wind, composition and ionization of air, air pressure, and materials airborne contaminants. If a stable homeostatic state is not achieved, then the pig are stressed, and will affect the balance of hormones and body enzymes which further affect the metabolism of livestock. This might also change the behavior of livestock, which in turn affects the production, reproduction and health of livestock.

East Nusa Tenggara as a semi arid area, the requirements for the physical factors of building cages for this area are: Building materials that are durable, relatively cheap and highly reflective of light; Low ability to store heat loads originating from livestock bodies; sufficient roof slope, usually 30-54° so that livestock is protected against heat, rain and wind; The ceiling of the building is quite high as needed; Guaranteed good air circulation, so that unhealthy air comes out and fresh air enters; The size of the room for livestock is quite adequate; and the longitudinal direction (axis) of the cage building is west east, different from the direction of the building in temperate regions or cold climates.

For farmers, it should make at least 4 (four) groups of cages to follow the life cycle of pigs, including: Sow cages before and during pregnant; birth cage; the cage of weaning; and the cage of fattening.

4. CONCLUSIONS

The reproductive performance of local pigs in East Nusa Tenggara Province is still low which appears from puberty to the age of first birth, litter size produced, birth weight of the piglet, number of piglet weaned, mortality is quite high and calving interval is long. Various methods that can be done to improve the performance of pigs reproduction are reproduction improvement through artificial insemination, import of livestock and selection. In addition, improvements in reproduction in feed management need to be done to improve litter size produced, birth weight of piglet, number of piglet weaned, reduce mortality and in an effort to shorten long calving intervals. Also, because maintenance in East Nusa Tenggara province is mostly traditionally and semi intensive, it needs to change its maintenance method by taking into account the health and cages aspects. In general, increasing production and reproduction of local pigs need to pay attention to breeding, feeding and management aspects.

REFERENCE

[BPS NTT] Badan Pusat Statistik Nusa Tenggara Timur 2016. 2015 Livestock statistics of East Nusa Tenggara Province. East Nusa Tenggara Province.

- Abah KO, Itodo JI, Ubah SA, Shettima I. 2019. Reproductive performance of pigs raised by intensive management system in Abuja, Nigeria. *Veterinary World Journal*. Vol.12(2):305-308. doi:10.14202/vetworld.2019.305-308.
- Dewantoro B, Soewandi P, Talib C. 2015. Development of local pig in Indonesia. *Wartazoa*. Vol.25(1):39-46. DOI: <http://dx.doi.org/10.14334/wartazoa.v25i1.1127>.
- Franzke B, Neubauer O, Cameron-Smith D, Wagner KH. 2018. Dietary protein, muscle and physical function in the very old. *Nutrition Journal*. Vol.10 (935): 41-54. doi: 10.3390/nu10070935.
- Ivic M, Tomovic V, Sevic R, Jokanovic M, Skaljac S, Dzinic N, Sojic B, Tasic T, Ikonc P. 2017. Carcass quality traits of three different pig genotypes, White Mangulica Duroc x White Mangulica and Large White Pigs, reared under intensive conditions and slaughtered at 150 kg live weight. *Proceeding Ceremony in International Meat Industry Conference (MEATCON2017)*. IOP Conf.Series:Earth and Environmental Science 85 (2017)012065. doi:10.1088/1755-1315/85/1/012065. Pp.1-6.
- Koketsu Y, Tani S, Lida R. 2017. Factors for improving reproductive performance of sows and herd productivity in commercial breedings herds. *Porcine Health Management Journal*. Vol.3(1):1-10. doi.10.1186/s40813-016-0049-7.
- Machado ST, Naas IDA, Reis JGMD, Caldara FR, Santos RC. 2016. Sows and piglets thermal comfort: A comparative study of the tiles used in the farrowing housing. *Journal of the Brazilian Association of Agricultural Engineering*. Vol.36(6):996-1004. doi:<http://dx.doi.org/10.1590/1809-4430-Eng.Agric.v36n6p996-1004/2016>.
- Oelke CA, Ribeiro AML, Noro M, Benardi ML, Denardin CC, Nunes PR, Velt FC, Winckler JC. 2018. Effect of different levels of total dietary fiber on the performance of sows in gestation and lactation. *Brazilian Journal of Animal Science*. R.Bras.Zootec. 47:1-9. doi:<https://doi.org/10.1590/rbz4720170299>.
- Salea HFV, Najoran M, Umboh JF, Ponto CJ. 2018. Effect of partly substitution of basal diet with sweet potato vines (*Ipomoea batatas*) meal on energy and protein digestibility of pigs. *Zootek Journal*. Vol.38(1):253-261.
- Sinha RC, Al Maruf A, Kundu AK, Rahman MdA, Islam MdT, Al Mamun MA. 2015. Determination of reproductive parameters of sows at rural areas of Bangladesh. *Journal of Advanced Veterinary and Animal Research*. J.Adv.Vet.Anim.Res. 2(1):74-79. doi:10.5455/javar.2015.b56.
- Skorput D, Dujmovic Z, Karolyi D, Lukoviz Z. 2018. Variability of birth weight and growth of piglets in highly prolific sows. *Journal of Central European Agriculture*. Vol.19(4):823-828. doi/10.5513/JCEA01/19.4.2355.
- Soewandi BDP, Sumadi, Hartatik T. 2013. Output estimation of pig in Tabanan Regency, Bali Province. *Buletin Peternakan*. Vol.37(3):165-172.
- Tur I. 2013. General reproductive properties in pigs. *Turkish Journal of Veterinary and Animal Sciences*. Turk J Vet Anim Sci. 37:1-5. doi:10.3906/vet-1105-14.
- Wientjes JGM, Soede NM, Knol EF, van den Brand H, Kemp B. 2013. Piglet birth weight and litter uniformity: Effects of weaning to pregnancy interval and body condition changes in sows of different parities and crossbred lines. *American Society of Animal Science Journal*. J.Anim.Sci. 91:2099-2017. doi:10.2527/jas2012-5659.