

# THE RELATIONSHIP BETWEEN PARITY TO PLACENTAL RETENTION AND THE IMPACT ON DAYS OPEN AND CALVING INTERVALS IN DAIRY COWS AT KPSBU LEMBANG

Idzni Hafilah<sup>1</sup>, Septiyani<sup>2\*</sup>, Nurcholidah Solihati<sup>3</sup>

<sup>1</sup>Veterinary Medicine Study Program, Faculty of Medicine, Padjadjaran University

<sup>2</sup>Department of Biomedical Sciences, Veterinary Medicine Study Program, Faculty of Medicine, Padjadjaran University

<sup>3</sup>Department of Animal Production, Faculty of Animal Husbandry, Padjadjaran University

\*email: [drh.septiyani@unpad.ac.id](mailto:drh.septiyani@unpad.ac.id)

## Abstract

Placental retention or retensio secundinae is the failure to completely pass all of the placenta from the uterus (cotyledon villi) for more than 8 hours after parturition. Retained placenta often occurs in dairy cows, which causes interference in reproductive efficiency, including days open and calving interval. This study aims to determine the relationship between parity and placental retention, and its impact on days open and calving intervals in dairy cows. Cows' reproductive data from North Bandung Cattle Farming Cooperative (KPSBU) Lembang were analyzed using descriptive analysis and path analysis. The results showed that parity has a significant relationship with placenta retention, and placenta retention with increasing parity can affect days open and calving interval in dairy cows at KPSBU Lembang. The t-statistical results had exceeded 1.96 with a significant p-value that did not exceed 0.05, so there was a significant relationship between the variables in the study. Dairy cows that have experienced retained placenta at North Bandung Cattle Farming Cooperative (KPSBU) Lembang have low reproductive efficiency, characterized by long open days and calving intervals exceeding the expected time.

**Keywords:** dairy cows, calving interval, days open, parity, placental retention

## HUBUNGAN PARITAS DENGAN RETENSI PLASENTA DAN DAMPAK PADA DAYS OPEN (MASA KOSONG) DAN CALVING INTERVAL (JARAK BERANAK) PADA SAPI PERAH DI KPSBU LEMBANG

### Abstrak

Retensio secundinae atau retensio plasenta merupakan salah satu gangguan reproduksi yang sering terjadi pada sapi perah. Hal ini tentunya akan mengganggu efisiensi reproduksi, termasuk Days Open dan Calving Interval. Retensio secundinae didefinisikan sebagai kegagalan pengeluaran seluruh plasenta dari uterus (kotiledon vili) secara sempurna selama lebih dari 8 jam setelah partus. Penelitian ini bertujuan untuk mengetahui hubungan antara paritas dengan retensio plasenta dan dampaknya terhadap hari beranak dan jarak beranak pada sapi perah. Penelitian dilakukan di Koperasi Peternakan Sapi Bandung Utara (KPSBU) Lembang. Metode yang digunakan adalah analisis data dengan menggunakan analisis deskriptif dan analisis jalur. Hasil penelitian menunjukkan bahwa paritas memiliki hubungan yang signifikan dengan retensi plasenta, dan retensi plasenta dengan meningkatnya paritas dapat mempengaruhi days open dan calving interval pada sapi perah di KPSBU Lembang. Analisis jalur didapatkan hasil t-statistik telah melebihi 1,96 dengan nilai p-value yang tidak melebihi 0,05, sehingga terdapat hubungan yang signifikan antar variabel dalam penelitian. Sapi perah yang mengalami retensio plasenta di Koperasi Peternakan Sapi Bandung Utara (KPSBU) Lembang memiliki efisiensi reproduksi yang rendah, yang ditandai dengan days open yang panjang dan calving interval yang melebihi waktu yang diharapkan.

**Kata kunci:** calving interval, days open, paritas, retensi plasenta, sapi perah

## INTRODUCTION

A well-developed growth of dairy farms in Indonesia has great potential for interconnected economic, social, and human welfare sectors in contributing to food fulfillment for national development. Milk is a crucial national food need, however, domestic dairy milk production

falls short of its demands. In 2019, the Ministry of Agriculture reported that the national milk demand was 4.3 million tonnes/year, with only 20% met by national domestic production and the rest of 80% rely on imports (Directorate General of Animal Husbandry and Animal Health, 2021). Increasing the national dairy

cow productivity could increase national domestic fresh milk (SSDN) production.

One of the largest dairy farming areas in Indonesia is West Java, specifically the North Bandung Cattle Farming Cooperative (KPSBU) Lembang in West Bandung. Dairy production in this cooperative faces many obstacles, including reproductive disorders, particularly placental retention. Factors causing placental retention include parity (Gaafar *et al.*, 2010), which influences reproductive efficiency in dairy cows. Reproductive efficiency, or the ability to produce good offspring, is measured by parameters such as Days Open (DO) and Calving Interval (CI). Days Open and Calving Intervals can be good indicators of assessing cow fertility, which correlates with several direct fertility measures.

Placental retention adversely affects farmers by reducing pregnancy and birth rates, which leads to economic losses. Understanding the relationship between parity and placental retention, as well as its impact on DO and CI for dairy cows, is crucial for improving dairy cows' productivity. This research aims to do just that by determining the dairy cows' productivity at KPSBU Lembang experiencing placental retention with different cow parties and the impact on individual DO and CI. By investigating these factors, the study aims to provide insights into improving the reproductive health and productivity of dairy cows, boosting the efficiency of dairy farms, and ultimately reducing dependence on imported milk.

## MATERIALS AND METHODS

Secondary data in this study were obtained from records at KPSBU Lembang. The recording included cases of retained placenta with manual removal, cow parity, and the number of distances between cows retaining placenta to pregnancy and subsequent births after the dairy cow retained placenta in January 2021. The appropriate samples were obtained. The criteria included 122 dairy cows of varying ages based on parity. The samples were traditionally reared cows fed concentrate and elephant grass in backyard pens. Feeding was only differentiated based on cow production status, such as dry season and lactation. After

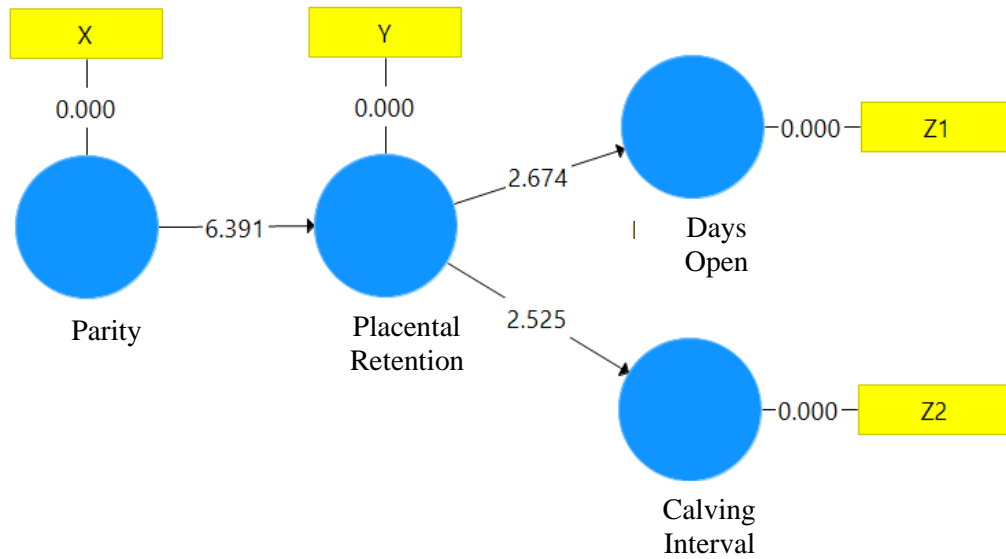
obtaining the data, it is presented using descriptive analysis and path analysis. Descriptive analysis describes the research results, supported by tables and further summarization (Sugiyono, 2010). Descriptive analysis can provide an overview of the results from samples that have been previously collected. Path analysis in this study uses the Structural Equation Modeling (SEM) method with latent variables. *Latent variables* cannot be measured directly and must be inferred from one or more other variables (Singgih, 2011). Structural Equation Modeling (SEM) can be used to explain the relationships between variables. Path analysis was used to analyze the relationship between parity, the incidence of placental retention, days open, and calving interval of dairy cows using SmartPLS 3.0 software.

## RESULTS AND DISCUSSION

The analysis was conducted using SmartPLS statistics to determine the relationships between the variables. Figure 1 illustrates the relationships between parity, placental retention, days open, and calving interval in dairy cows at KPSBU Lembang. It highlights how parity affects the incidence of placental retention and how this, in turn, influences days open and calving interval.

It can be seen in Figure 1 that parity has a positive effect on placental retention ( $T > 1.96$ ). The path coefficient between parity and placental retention was 6.391. Placental retention positively affected Days Open and Calving Interval ( $T > 1.96$ ) with values of 2.674 and 2.525, respectively. To find out the relationship between each variable, you can compare the t-statistics or t-counts obtained. The resulting t-count must be greater than the one-tail t-table, namely 1.96 for a standard error of 5% or a p-value below 0.05 (Hair *et al.*, 2021), which can be seen in the Path Coefficients values in Table 1.

Figure 1 indicates that parity has a significant positive effect on placental retention, with a path coefficient of 6.391 ( $T > 1.96$ ). Placental retention has a positive impact on both days open and calving interval, with T-values of 2.674 and 2.525, respectively.



**Figure 1.** Relationship between parity (x), placental retention (y), days open (Z1) and calving interval (Z2) in dairy cows at KPSBU Lembang.

**Table 1.** Path Coefficient values between variables, namely parity, placental retention, days open, and calving interval

Relationship between Variables	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics ( O/STDEV )	P-Values
Parity → Occurrence of Placental Retention	0.519	0.518	0.081	6.391	0.000
Placental Retention → Days Open	0.188	0.183	0.070	2.674	0.008
Retention Placenta → Calving Intervals	0.182	0.178	0.072	2.525	0.012

To determine the strength and significance of these relationships, the t-statistics or t-counts obtained are compared to the critical value of 1.96 for a one-tailed test at a 5% standard error, or a p-value below 0.05 (Hair et al., 2021). These relationships and their significance are detailed in the Path Coefficients values presented in Table 1.

#### The Relationship between Parity and Cases of Placental Retention

Parity has a significant positive influence on placental retention in dairy cows, as indicated by the t-statistics value exceeding 1.96 (Table 1). Placental retention occurs in both primiparous and multiparous cows but is more prevalent in multiparous cows, with 89 cases compared to 33 in primiparous cows (Table 2).

**Table 2.** Number of Dairy Cows with Placental Retention Cases at Different Parities in January 2021 at KPSBU Lembang.

Parity	Number of Cows (head)
1	33
2	43
3	29
4≥	17
Total	122

In primiparous cows, placental retention can result from an underdeveloped uterus, inadequate nutrition, inappropriate feeding, stress from lack of birthing experience, hormonal disturbances, and reduced reproductive performance (Raynardia *et al.*, 2021). Multiparous cows are more prone to placental retention due to hormonal imbalances associated with increased parity and age, as the number of parities increases often go hand in hand with increasing age (Islam *et al.*, 2012; Gafaar *et al.*, 2010; Okta *et al.*, 2016).

As parity increases, the feed requirements of dairy cows also need to be considered. According to Grandl *et al.* (2018), the feeding regimen, which does not differ between primiparous and multiparous cows and only adjusts based on reproductive status, may contribute to higher retention in multiparous cows. This mismatch between feed and nutritional requirements ratio can result in higher Feed Conversion Ratio (FCR) imbalances and slower metabolism in older cows. A higher FCR indicates that more feed is required to produce one production unit (e.g. animal body weight). This imbalance usually occurs if the feed does not match the nutritional requirements of the livestock, resulting in decreased feed-to-production conversion efficiency. Mohon konfirmasinya, apakah ketidakseimbangan rasio pakan dan kebutuhan nutrisi menyebabkan FCR yang lebih rendah atau tinggi? Karena FCR yang rendah berarti semakin baik tingkat konversinya, yang biasanya terjadi jika pakan sesuai dengan kebutuhan nutrisi ternak.

The results of the field study also showed that the incidence of retention was higher in multiparous cows than in primiparous cows, which could be due to nutritional deficiencies causing an imbalance in hormone levels (Abraham, 2017). This nutritional deficiency can be due to insufficient feeding or rumen

papillae which have insufficient nutrient absorption, causing a decreased Volatile fatty acids (VFA) production and energy availability (Scalia *et al.*, 2006). VFA are products of rumen microbial degradation of substances such as cellulose, pentosans, and proteins, and can provide 70-80% of energy for ruminants (Bainbridge *et al.*, 2018). A certain VFA ratio in the rumen fluid has a direct influence on the NER (Net Energy for Milk Production) of dairy cows, causing a negative energy balance (NEB). This case of NEB is closely related to a reduced body's immune system (Scalia *et al.*, 2006) which can result in reproductive disorders like placental retention (Konyves *et al.*, 2009).

NEB occurs when energy production is lower than the animal's basic and production needs, which reduces reproductive performance. NEB can also occur during lactation or pregnancy (Suharyono *et al.*, 2010). Additionally, reproductive failure can stem from mineral deficiencies or imbalances, thereby elevating the risk of placental retention.

### Relationship between placental retention and length of days open

Placental retention positively impacts the length of days open, as indicated by the t-statistics value greater than 1.96 (Table 1, Table 4.3). Table 3 and Figure 4.2 illustrate that dairy cows with retained placenta at KPSBU Lembang have extended days open periods, the interval between the last calving and the next successful mating and pregnancy (Atabany *et al.*, 2011).

Primiparous cows (first-time calvers) with retained placenta have days open ranging from 50 to 442 days, averaging around 190 days. In contrast, multiparous cows (having given birth more than once) have days open ranging from 50 to 426 days, averaging around 215 days.

**Table 3.** Days open in dairy cows experiencing retained placenta with parities that have been grouped at KPSBU Lembang.

Time (Day)	Primipara			Multiparous		
	Number of Cows	%	Mean	Number of Cows	%	Mean
≤90	5	15.15	69.4	13	14.6	76.54
≥91	28	84.85	211.61	76	85.4	239.14
Total	33	100	190.1	89	100	215.39

These results indicate that multiparous cows with retained placenta have 25 days longer days open than primiparous cows. Both groups exceed the standard days open limit of 60-90 days, indicating low reproductive efficiency (Yulyanto *et al.*, 2014).

Days open are influenced by several factors, such as nutrition, herd health, genetics, cow age, bull fertility, environment, and reproductive health. Each factor plays a significant role in cattle reproductive efficiency (Duggan *et al.*, 2021). Dairy cows with retained placenta will experience further low reproductive efficiency if they also develop metritis.

Metritis generally occurs immediately after parturition until the first 20 days postpartum. The highest percentage incidence of metritis is on the 10th postpartum day, which is 40%. There are indications that dairy cows with retained placenta with metritis will have a more severe outcome than either case alone. Metritis can be caused by abnormal labour complications such as abortion, placental retention, premature birth, multiple births, dystocia, and injury during the birth process. Cases of metritis can negatively affect the reproductive performance and fertility of dairy cows due to disruption of uterine condition, which affects the oestrous cycle and embryo development (Giuliodori *et al.*, 2013) which will interfere with production results in the form of days open and calving interval due to disruption of the cow's reproductive organs. So, it is necessary to treat placental retention properly to avoid inflammation or metritis.

Days open will affect the dairy cow milk production. Extended days open negatively impact milk production, breeding success, and calving intervals, potentially prolonging gestation periods beyond normal (LeBlanc, 2005). High variation in days open is likely

caused by the interaction of maintenance management factors and individual animal factors. Postponed open days can occur due to the risk of disrupting ovarian activity in cows experiencing retained placenta due to several things, such as livestock parity (Jepri *et al.*, 2021).

#### Relationship between placental retention and length of calving interval

Research results data from Table 4.6. shows that retained placenta has a positive influence on the calving interval (CI) as indicated by a t-statistics value exceeding 1.96. This can be supported by the explanation in Table 4.

The average CI for both primiparous and multiparous dairy cows with retained placenta experience exceeds the normal limit of 365-425 days (12-14 months). Primiparous and multiparous dairy cows have an average CI of 470 days and 496 days, respectively, a difference of 26 days. CI, the interval between one birth and the next, is a benchmark in assessing the cattle productivity to produce calves in the ideal time. The extended CI in cows with retained placenta at KPSBU Lembang indicates poor reproductive efficiency, as optimal reproductive efficiency is indicated when cows produce new offspring within a year. The long CI can also be caused by long days open (DO), as a retained placenta can delay the subsequent pregnancy by 2-6 months (Maas, 2008).

The difference in results indicates a difference in the length of the fertile estrus cycle. The data indicates a delay in fertile time after birth. Hence, animals that experience placental retention only succeed in producing pregnancy a few days longer than those who do during regular times.

**Table 4.** *Calving Intervals* in dairy cows experiencing retained placenta with parities that have been grouped at KPSBU Lembang

Time (Day)	Primipara			Multiparous		
	Number of Cows	%	Mean	Number of Cows	%	Mean
≤365	4	12.1	344.75	14	21.3	357.07
366-426	8	24.2	388.88	8	8	396.38
≥427	21	63.7	524.86	67	69.7	537.04
Total	33	100	470.06	89	100	496.09

Several factors cause high CI values in dairy cows, including feed factors that do not match the cows' nutritional needs (Wahyudi *et al.*, 2013), service per conception, length of days open, first litter postpartum, postpartum mating, body condition score, length of weaning time, length of lactation, and reproductive diseases.

Placenta retention can cause inflammation of the metritis, which prevents breeding and causing temporary (infertile) or permanent reproductive disorders (Sari *et al.*, 2016). Reproductive disorders in cattle can cause Corpus Luteum Persistent (CLP), which extends the lambing cycle and delays the recovery of reproductive organs. This is also supported by the development of ovarian follicles and increased estradiol levels because it becomes a standard parameter for the development of reproductive organ readiness in postpartum cows.

Low reproductive efficiency can also result from non-optimal follicle diameter and estradiol levels, as increasing estradiol in blood circulation is crucial for initiating estrus postpartum (Perry *et al.*, 2014). Production of estradiol, an estrogen hormone, signals the follicle readiness for the start of postpartum estrus (ovarian development), which impacts estrus quality and reproductive efficiency (Alfons *et al.*, 2022). Low estrogen levels delay estrus signs, complicating detection and timely insemination (AI), which leads to missed opportunities and extended CI (Heffner and Schust, 2008). Other factors contributing to prolonged CI include inaccurate AI timing, poor observation of estrus, insufficient health worker performance, and prolonged weaning, which delays remating (Jepri *et al.*, 2021).

Suckling calves can delay reproductive activity postpartum by suppressing gonadotropins release in the pituitary gland, causing a delay in follicular development. This leads to insufficient estrogen levels for signs of estrus to appear, making it difficult for farmers to detect estrus and causing a delay in lambing cycles. CI improvement can be done with reproductive disorders prevention programs, especially during the transition period (Nowak *et al.*, 2012), including supplementing minerals such as selenium and vitamins A, D, and E. Several researchers have proven the importance of selenium and vitamin E for female fertility in vivo (El-Shahat and Monem, 2011) and in vitro. Selenium and vitamin E affect the speed of

estrus onset time and increase the incidence of conception. This is because selenium and vitamin E are antioxidants that stimulate the steroidogenesis process and stimulate the anterior pituitary gland to secrete steroid hormones and initiate folliculogenesis in the ovaries. These supplements, though not provided on every condition, are provided for cows with poor nutritional conditions to prevent placental retention and improve reproductive outcomes.

## CONCLUSIONS

Based on the results of the study, it can be concluded that both primiparous and multiparous parities can affect the incidence of placental retention in dairy cows. Increasing parity with placental retention can increase the length of days open and calving interval in dairy cows. The path analysis, with t-statistic results exceeding 1.96 and significant p-values below 0.05, confirms the relationship between these variables. Dairy cows experiencing placental retention at KPSBU Lembang have low reproductive efficiency, characterized by the length of lambing and calving interval that exceeds the expected time marked by the high value of days open and calving interval from the expected standard limit. To prevent placental retention, it is necessary to feed cows with nutrition tailored to their needs, including ensuring an appropriate ratio and quality of feed during both dry periods and lactation. Supplementing cows with selenium and vitamin E as needed can help minimize stress to avoid hormonal disorders.

## REFERENCES

- Abraham, F., 2017. An overview on functional causes of infertility in cows. *JFIV Reprod Med Genet*. 5:1-6.
- Alfons, M. P., Budiyo, A., dan Setyawan, E. M. N. (2022). Kajian Profil Hormon Estradiol Berdasarkan Perkembangan Folikel dan Ovarium Sapi Potong Postpartus. *Jurnal Sain Veteriner*, 40 (1): 24-31.
- Atabany, A., Purwanto, B. P., Toharmat, T., & Anggraeni, A. (2011). Hubungan masa kosong dengan produktivitas pada sapi perah Friesian Holstein di Baturraden,

- Indonesia. *Media peternakan*, 34(2), 77-77.
- Bainbridge, M. L., Saldinger, L. K., Barlow, J. W., Alvez, J. P., Roman, J., and Kraft, J. (2018). Alteration of rumen bacteria and protozoa through grazing regime as a tool to enhance the bioactive fatty acid content of bovine milk. *Front. Microbiol.* 9:904.
- Directorate General of Animal Husbandry and Animal Health. (2021). *Kementan Berkomitmen Kembangkan Produksi Susu Segar Dalam Negeri*. Diktat. Direktur Jenderal Peternakan Departemen Pertanian: Jakarta.
- Duggan, S., Pirelli, G., Estill, C., Ranches, J., and Weber, D. W. (2021). *Beef cow-calf management guide*. Oregon State University Extension Service. United States of America.
- El-Shahat, K. H., & Abdel Monem, U. M. (2011). Effects of dietary supplementation with vitamin E and/or selenium on metabolic and reproductive performance of Egyptian Baladi ewes under subtropical conditions. *World Applied Sciences Journal*, 12(9), 1492-1499.
- Gaafar, H. M. A., Shamiah, S. M., Shitta, A. A., & Ganah, H. A. B. (2010). Some factors affecting on retained placenta and its effects on postpartum reproductive performance and milk production of Friesian cows. *Slovak Journal of animal science*, 43(1), 6-12.
- Giuliodori, M. J., Magnasco, R. P., BecuVillalobos, D., Lacau-Mengido, I. M., Risco, C. A., & de la Sota, R. L. (2013). Metritis in dairy cows: Risk factors and reproductive performance. *Journal of Dairy Science*, 96(6), 3621- 3631.
- Grandl, F., Zeitz, J. O., Clauss, M., Furger, M., Kreuzer, M., & Schwarm, A. (2018). Evidence for increasing digestive and metabolic efficiency of energy utilization with age of dairy cattle as determined in two feeding regimes. *Animal*, 12(3), 515-527.
- Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., Ray, S., & Ray, S. (2021). An introduction to structural equation modeling. *Partial least squares structural equation modeling (PLS-SEM) using R: a workbook*, 1-29.
- Heffner, L. J., and Schust, D. J. (2008). *At a Glance Sistem Reproduksi*. Jakarta: Erlangga.
- Islam, M. H., Sarder, M. J. U., Rahman, M., Kader, M. A., & Islam, M. A. (2012). Incidence of retained placenta in relation with breed, age, parity and body condition score of dairy cows. *International Journal of Natural Sciences*, 2(1), 15-20.
- Jepri, S., Siska, I., & Anggrayni, Y. L. (2021). Efisiensi Reproduksi Sapi Perah di Koperasi Merapi Singgalang Kota Padang Panjang. *Jurnal Pengembangan Ilmu Pertanian*, 10(3), 484-490.
- Konyves, L., Szenci, O., Jurkovich, V., Tegzes, L., Tirian, A., Solymosi, N., Gyula, G., & Brydl, E. (2009). Risk Assessment and Consequences of Retained Placenta for Uterine Health, Reproductive and Milk Yield in Dairy Cow. *Acta Vet. BRNO. Z.* 78:163- 172.
- LeBlanc, S. (2005). Overall Reproductive Performance of Canadian Dairy Cows Challenge We Are Facing. *Advance in Dairy Technology*, 17: 137-148.
- Maas, J. 2008. Treating and preventing retained placenta in beef cattle. *UCD Vet Views California Cattlemen's Magazine*.
- Nowak, W., Mikula, R., Zachwieja, A., Paczynska, K., Pecka, E., Drzazga, K., & Slosarz, P. (2012). The Impact of Cow Nutrition in the dry Period on Colostrums Quality and Immune Status of Calves. *Polish Journal of Veterinary Science*. 15(1):72-78.
- Okta, E. F., Soeharnoso, & Wurlina. (2016). Hubungan Umur Terhadap Kasus Retensio Sekundinarum dan Dampaknya Terhadap Birahi dan Kebuntingan. *Ovozoa*, 5(1).
- Perry, G. A., Swanson, O. L., Larimore, E. L., Perry, B. L., Djira, G. D., and Cushman, R. A. (2014). Relationship of follicle size and concentrations of estradiol among cows exhibiting or not exhibiting estrus during a fixed-time AI protocol. *Domestic Animal Endocrinology*, 48: 15-20.
- Sari, E., Hartono, M., dan Suharyati, S. (2016). Faktor-faktor yang memengaruhi service per conception sapi perah pada peternakan rakyat di Provinsi Lampung. *J. Ilmiah Peternak Terpadu*, 4: 313-318.

- Scalia, D., Lacetera, N., Bernabucci, U., Demevere, K., Duchateau, L., & Burvenich, C. (2006). In vitro Effects of Nonesterified Fatty Acids on Bovine Neutrophils Oxidative Burst and Viability. *Journal of Dairy Science*. 89:147-154.
- Singgih, S. (2011). *Structural Equation Modeling (SEM) Konsep dan Aplikasi dengan AMOS 18*. Jakarta: PT Elex Media Komputindo.
- Sugiyono. 2010. *Metode Penelitian Pendidikan Pendekatan Kuantitatif, kualitatif, dan R&D*. Bandung: Alfabeta.
- Suharyono, C., Kusumaningrum, E., Wahyono T. & Ansori, D. (2010). *Inovasi Pakan Komplit Terhadap Fermentasi Rumen, Kecernaan dan Pertambahan Berat Badan Pada Ternak Domba*. Laporan Teknis, Pusat Aplikasi Teknologi Isotop dan Radiasi. Jakarta: Badan Tenaga Nuklir Nasional.
- Raynardia, Y. L., Adyatama, A., A'yun Z. Q., Rosita, G., & Prawesti, L. N. (2021). Peran Kortisol dalam Kasus Kawin Berulang pada Sapi Perah Peranakan Friesian Holstein (PFH). *Jurnal Peternakan Sriwijaya*, 10 (2): 39-49.
- Wahyudi, L., Susilawati, T., dan Wahjuningsih, S. 2013. Tampilan reproduksi sapi perah pada berbagai paritas di Desa Kemiri Kecamatan Jabung Kabupaten Malang. *Jurnal Ternak Tropika*. 14(2):13--22
- Yulyanto, C. A., Susilawati, T. & Ihsan, M. N. (2014). Penampilan Reproduksi Sapi Peranakan Ongole (PO) dan Sapi Peranakan Limousin di Kecamatan Sawoo Kabupaten Ponorogo dan Kecamatan Tugu Kabupaten Trenggalek. *Jurnal Ilmu-Ilmu Peternakan* Vol. 24(2):49-57.