

## Conference Paper

# Animal Welfare As Stress Management to Improve Beef Cattle Reproduction

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## Abstract

The efficiency of reproduction practices is one of the indicators of animal health and animal welfare situation. Deprived reproductive performance in a beef cattle farm may indicate the presence of animal welfare problems. In this study, we analyze the research and reviews on how the poor practices of animal welfare will affect the reproduction performance of beef cattle. Based on the analysis, we found that poor practical of animal welfare in cattle such as overcrowded population, heat stress, and discomfort animal will give a bad impact in the secretion of adrenocorticotrophic hormone (ACTH) and cortisol hormone. Imbalance of hormones secretion may induce ovarian cycle disorder and depressing immunity of the uterine tract. The high risk of those disorders may cause bad reproduction performance indicator which is prolonged DO, reduced CR, and increased S/C and CI. We suggest that good animal welfare practices as stress management in beef cattle are expected to overcome the reproduction problems, and enhance the animal's immunity. In conclusion, good animal welfare practices prevent the occurrence of a reproduction problem and improve the beef cattle reproduction through better animal health.

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## 1. Introduction

Good handling or good behaviour towards animals used to fulfill people's necessities described by Etim et al. as animal welfare [1]. People start to realize that it is important to consider more about animal welfare in farm animal. They aware that if they took the advantages from animals, they should fulfill the animal's basic necessity to have good husbandry. This concern appeared to the public because of the beliefs that animal can feel pain [2]. Furthermore, the emphasis on the judgment, approaches, and principles regarding animal welfare had seized by the public, both as the civilian and as buyer [3–9]. Animal welfare issue is multi-facet which entails not only the scientific and ethical extents but also involves economic and political dimensions [10].


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There is a generally accepted truth that nowadays the intensive, profit-oriented animal farming systems have replaced the old-style extensive farming which can no longer produce enough food to feed all the hungry people in the world [11]. Economic loss in the long run possibly may occur because of the behavioural and psychological stress which triggered by overcrowded population, stress-induced environment and extreme separation of animal [11, 12]. It is important to manage animal well-being to prevent that economic loss projection. Animal well-being determined by both external and internal factors. External factors affecting the well-being of an animal are defined as the psychosocial and physical stimuli, and the internal factor are both mental and physiological response of the animals. Variance in animal behaviour, genetics differences, individual variation, social state, the intensity and farm management style, period and incidence of stimuli are facets related to those factors.

The result of factors and variables interactions in managing the animal well-being may explain the effects of some stressors on reproductive practices, animal metabolism, and immune response and additionally the quality of farming practices, which encompass both animal welfare and productivity [13]. Therefore, by maintaining a good animal-well-being by paying attention, their welfare can prevent stressors affecting the natural animal reproductive physiology. This paper focus on reviewing animal welfare as stress management, by terms can prevent the appearance of internal and external stressors and its correlation with reproduction in beef cattle.

## 2. Animal Welfare

### 2.1. Definition and approach of animal welfare

The word 'welfare' is not consistently defined and used. However, the explanations of animal welfare suggested by numerous researchers redirect their diverse backgrounds. This dynamic approach is resulting from dissimilar attitudes and methodologies towards an animal's well-being [14]. Thus, the definitions of animal welfare proposed by various researchers reflect their different backgrounds. Definitions of welfare have also been recommended according to social improvements of the public viewpoint in the connection between man and animals [13].

Carenzi and Verga suggested that there is three major approaches that used to define and find methods to assess welfare level they are highlighting more on the biological aspect, physiological aspect and natural living aspect [13]. It has been explained that the biological approach underlines the physiological function of an animal comprising the

growth, reproduction, health, and behavior of the animal. In this approach, maintaining good welfare means the fulfillment of biological needs is an obligation [14]. On the other hand, another approach emphasizes more in the psychological aspects of welfare and that the connection between stress and welfare is the central issue and is a complex matter [15]. This approach is closely related with definition of welfare by World Health Organization (WHO) “a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity” [16] and Hughes who defined animal welfare as-as “a state of complete mental and physical health, where the animal is in harmony with its environment” [17]. Major Proposed animal welfare approach stated by some researcher summarized in Table 1.

The report of the “Brambell Committee” is the first scientific inquiry which developed as the Five Freedoms[18]. This Five Freedoms is the most accepted scientific approach to animal welfare, uses largely and externally measurable factors to evaluate animal welfare while avoiding anthropomorphism [19]. The method is resilient on the physical aspects of welfare such as housing, management, and nutrition, but frail on the emotional aspects of animal lives [13]. The five freedoms later define deeply by the Farm Animal Welfare Council, an independent advisory body established by the British Government in 1979 (Table 2).

Providing welfare to the animal is not regarded as a radical, but it is very conservatives where reflecting the effort to limit how animals can be used, to limit their pain and suffering [24]. Damron stated in the Introduction to Animal Science that animal welfare is not opposed to animal use; it is conflicting to animal use that leads to friction and suffering of the animal [24]. Animal welfare was first identified as a priority by OIE in its 2001 to 2005 strategic plan where the OIE Member Countries and Territories assigned the organization to take the international coordination on animal welfare to elaborate commendations and guiding principle covering animal welfare applies, endorsing that animal health is a key component of animal welfare [25].

## 2.2. Animal welfare and productivity

Animal welfare together with the supply chain have been an issue for every type of production system [26]. A study by Czekaj et al. suggests that there is an indirect association between animal welfare and productivity which might be caused by the quality of the management [27]. The management quality will affect directly to both productivity and animal welfare. On the other hand, animal welfare will affect indirectly to the farm productivity to output which leads to low or high productivity (Fig. 1). Hence, the animal

TABLE 1: Major animal welfare approach.

Researcher	Approach	Explanation
Carenzi and Verga [13]	Biological aspect	Underlines the physiological function of an animal comprising the growth, reproduction, health, and behaviour of the animal. In this approach, maintaining good welfare means the fulfilment of biological needs is an obligation [13, 14]
	Psychological aspect	Considering feelings or emotions as a key element in determining the quality of life, which includes not only the state of the animal's body but also its feelings [13, 14]
	Natural living aspect	Emphasizes natural living, stating that animals should be allowed to live according to their natural attitudes and behaviour, mainly developing and using their natural adaptations [13, 14]
Fraser and Broom [20]	Biological functioning	Addressing issues such as disease, injury, poor growth rates, and reproductive problems that are bad for the animal and also for the viability of the farm [20]
	Affective state	Focus on whether the animals are suffering from unpleasant feelings, such as pain, fear, or hunger, or whether they are experiencing positive states, such as pleasure associated with play [20]
	Natural living	Whether the animal can live a relatively natural life and can express natural behaviour [20]
Dockés and Kling-Eveillard [21]	Biological and technical definitions	Fundamental needs of animals and the freedoms should be given, as well as the possibilities to cope with the environmental challenges [21, 22]
	Regulation approach	Recognize the animal as a sensitive being, and as such it has to be put in conditions 'compatible with the biological needs of the species' which later translate the concepts into laws [21, 22]
	Philosophical approaches	Consider the animal's status and its role in the human society [21, 22]
	Communication between human and animal	Importance of the farmer-animal interaction and its effect on industrial breeding systems [21, 22]

Source: [13,14, 20–22]

welfare practices still will give any effect on the farm productivity, if the animal welfare practice is bad it will indirectly lower the production results. This may happen because the bad animal welfare practice will affect the animals physiology, thus the productivity will decrease as the body metabolism is altered.

Animal welfare and productivity also bring up a theoretical consideration that discussed well by McInerney which emphasize that there is an intolerable level of animal

TABLE 2: The Five Freedoms of the Farm Animal Welfare Council.

No	Principle	Implementation
1	Freedom from hunger and thirst	by ready access to fresh water and a diet to maintain full health and vigour.
2	Freedom from discomfort	by providing an appropriate environment including shelter and a comfortable resting area
3	Freedom from pain, injury or disease	by prevention or rapid diagnosis and treatment
4	Freedom to express normal behaviour	by providing sufficient space, proper facilities and company of the animal's own kind.
5	Freedom from fear and distress	by ensuring conditions and treatment that avoid mental suffering.

Source: [23]

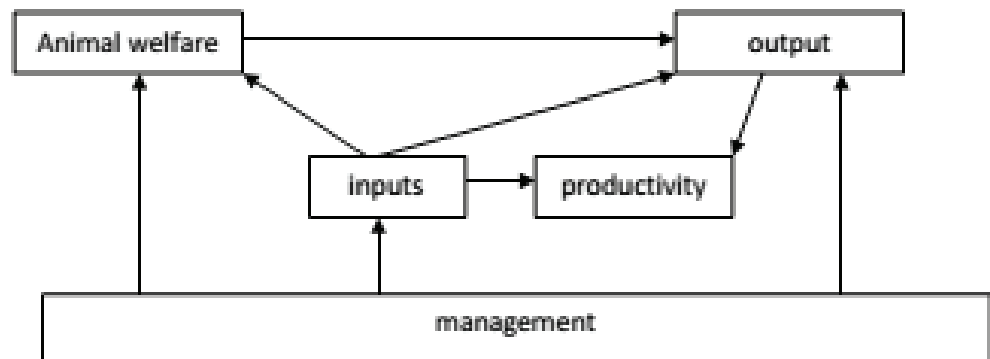
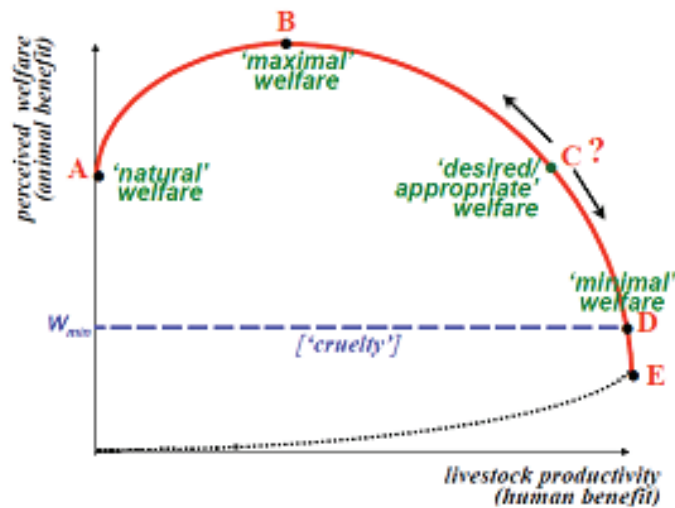


Figure 1: The relationship between animal welfare, management and productivity [27].

welfare (cruelty) illustrated by the line between point  $W_{min}$  until point D (Fig. 2) [28]. This line explains an animal welfare level which comprises neglect and abuse and any points below this line is unacceptable. The y-axis in the graph below represents the perceived welfare or animal benefit, and x-axis represent livestock productivity or human benefit. The D point shows low productivity and low animal welfare, while the E point is the lowest level of productivity is located under the 'cruelty' line. Point A expresses the normal well-being of animal or 'natural' welfare with a normal or desired productivity, this point also in line with 'desired' or appropriate welfare in point C. Point B, which stands for 'maximal welfare' represent the highest production level than any other point. However, point A, B and C have illustrated how the good animal welfare practices in a farm will resulting in a good livestock productivity



**Figure 2:** Theoretical relationship between animal welfare level and livestock productivity level [28].

### 3. Stress

Stress encompasses the failure of an animal to deal with a particular situation [29, 30]. The animal can cope with that particular situation if they possess the controllability and predictability. A hungry animal may not get stress if it can solve the problem by looking for food, this later called as controllable [27]. Meanwhile, the animal who has predictability will alleviate the effects of the stressful situation, even they may not be able to control the unfavourable condition. In other words, the stress condition will arise if there is no controllability or predictability when a stressful condition happens to an animal [31]. If this situation is not diminished and last longer will cause the chronic stress of an animal.

According to Etim et al. the causal of stress in an animal is either can be caused by physiological stressors such as bad handling, novelty and overcrowded population or physical stressors such as hunger, thirst, fatigue, injury, or extreme heat [1]. However, the strongest stressors in farm animal are fear and pain that will eventually affect the quality and worth of the meat from stressed animals [32]. These two stressors can appear when the welfare of the animal is not fulfilled. The fulfillment of the animal welfare will prevent the stress condition of the animal because their physiology and psychological condition is in a normal state. Thus, the absence of stress is a potential indicator of animal welfare, although there is no standard definition of stress and no accepted biochemical assay system to measure stress [33].

## 4. Stress and Beef Cattle Reproduction Performance

Stress condition in an animal will activate a very complex homeostatic mechanism and closely related to animal welfare as the well-being of an animal will never be achieved in a stress condition [31, 34]. In this mechanism, the unspecific response of stress involves the Hypothalamus-Pituitary Adrenal (HPA) axis as the vital part. Threatened homeostasis in a long period can induce the hyperactivity of neuroendocrine system which will give a bad impact on animal's well-being [35]. The deprived animal welfare may lessen the lifespan, damage the animal growth, weakened the reproduction, damaged the body, predisposed disease, immunosuppression, impaired adrenal activity, behaviour anomalies and self-narcotization [29].

### 4.1. Hormonal imbalance

Stress can cause abnormalities in hormonal pattern and clinical manifestations [36]. A report by Dobson and Smith shows that an endocrine regulatory point exists whereby the stress condition limits the efficacy of reproduction [30]. Scientist has agreed that general stress exerts its influence through the endocrine system. Yet this mechanism is still being debated, the stress and its association of the hormones of the adrenal cortex have acknowledged getting significant consideration. The important involvement of adrenal glands in hormonal response to stress is because of its involvement in both the hypothalamic–pituitary–adrenocortical axis and the sympathy-adrenomedullary system [37]. A stressful environment drives the secretion of Corticotropin-Releasing Hormone (CRH) which acts releasing Adenocorticotropin hormone (ACTH) from the pituitary anterior, which functions as a stimulant for cortisol release and other glucocorticoid hormones from the adrenal cortex (Fig. 3) [38].

### 4.2. Hormonal imbalance and reproduction

The effect of stress on pituitary gland gives bad impact on two important gonadotropic hormones they are Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH). In the male, LH promotes the production and release the androgen in male while in the female, FSH and LH act directly on ovarium. If there is a problem with the ovarium other hormones produced by ovarium such as estrogen, and progesterone which produced by corpus luteum will also be disturbed the normal physiology of female reproductive hormone is presented in Fig. 4.

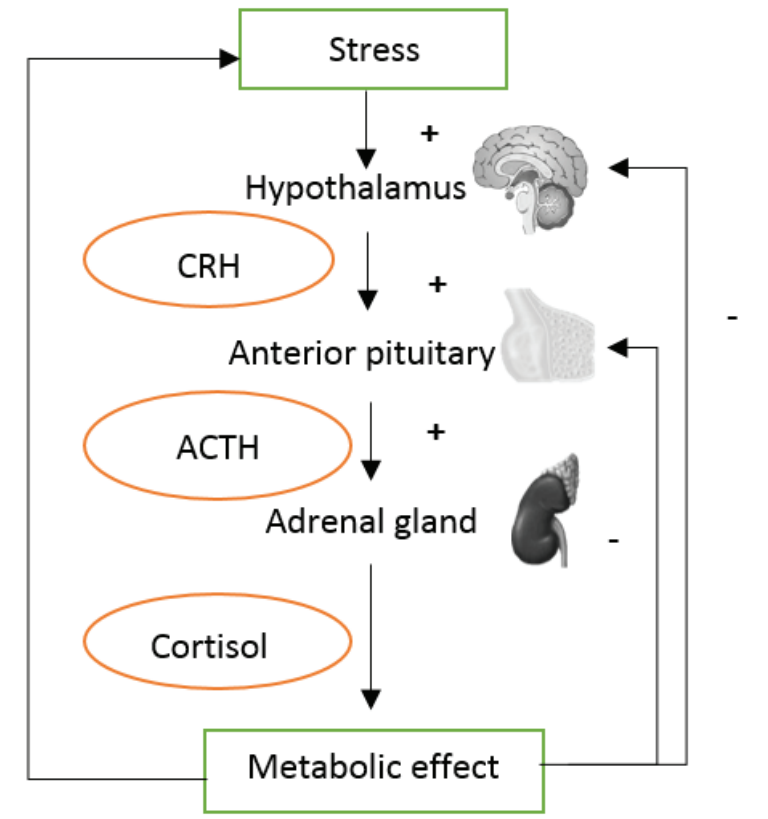


Figure 3: The hormonal mechanism of stress [38].

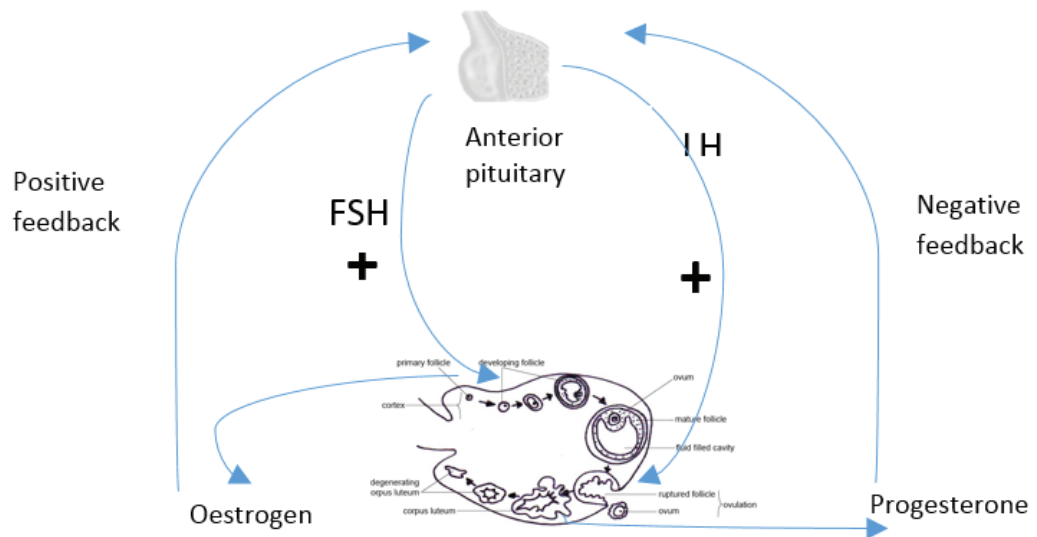


Figure 4: The hormonal physiology of female anterior pituitary and ovarium [38].

In a stressful condition, there is a negative feedback effect of progesterone on luteinizing hormone (LH) and the presence of glucocorticoid also cause inhibitory effects on LH. If this condition happens to cattle during its estrous cycle (end of pro-estrus or end of estrus), it will cause a delay or even prevent ovulation in cow because LH acts in



stimulating the release of the ovum from the ovary of female cows. The lack of ovulation in females will lower the libido in male cattle and subsequently affects the production of testosterone and impedes spermatogenesis. Aside from affecting testosterone and spermatogenesis production, inhibited LH will also impede progesterone secretion by corpus luteum. This heat stress will affect GnRH hormone production and will disturb cattle estrous cycle and hormones production. Thus cattle will not show signs of arousal, delayed puberty in young cattle and lower cattle fertility [38]. Because stress condition impairs the FSH and LH secretion, the level of prostaglandin F2 alpha (PGF2 $\alpha$ ) will also increase as the negative feedback from progesterone is inhibited [39, 40].

## 5. Correlation of Stress and Beef Cattle Immunity

### 5.1. Glucocorticoids and uterus immunity

Stress on beef cow causes the excess release of glucocorticoids group especially cortisol that impacts decreasing cow uterus immunity. Events stress caused the release of excessive cortisol is explained through the mechanism of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic and adrenomedullary (sympathetic) systems. Stress conditions induce secretion of the hormone ACTH in the hypothalamus. ACTH alone can induce increasing secretion of the hormone cortisol in the adrenal gland. Excess cortisol inhibits leukocyte performance as immune cells towards the uterine tissue [41] — the negative impact of glucocorticoid in different immune cells summarized in Table 3.

During in conditions of immune suppression, the proliferation of leukocytes (especially lymphocytes and neutrophils) is severely depressed. Then also the fundamental functions of these cells, such as the ability to aggregate and phagocytosis of neutrophils, cytotoxic activity of lymphocytes, as well as the production of chemotactic cytokine IL-8 activating these leukocytes are usually reduced at this time [42]. The poor performance of immunity beef cow could risk to pathogen invasion either high pathogenic microbial (BVDV, IBR, and *Brucella* sp.) or opportunistic pathogenic microbial (*Staphylococcus* sp., *Streptococcus* sp., *Escherichia coli*, *Arcanobacterium pyogenes*, *Fusobacterium necrophorum*). The extensive invasion can be led to inflammation of the uterus. The degree of infection of the uterus includes clinical endometritis, subclinical endometritis, metritis, and pyometra. The uterine infection causes poor reproductive performance of beef cow [43–45].

Excess cortisol on stress condition also inhibits growth factor hormone mainly insulin-like growth factor-1 (IGF-1) and Prostaglandin. Insulin-like growth factor-1 (IGF-1) that is necessary for during embryo implantation [41]. IGF-1 together with other growth and cytokine (IL-1, IL-6) stimulate luminal and glandular epithelia proliferation that essential for receptivity of uterus to embryo implantation. Also, IGF-1 also induces development and maturation embryo before implantation in the uterus [46–48]. Thus, that lacked IGF-1 affected by stress condition could lead implantation and pregnant failure. On the other hand, shortage Prostaglandin because of stress condition could inert uterine muscle of beef cow thus is still high prevalence the disease caused inert uterine muscle especially post-partus time in the field. The disease such as uterine involution and retention fetal membrane [42].

TABLE 3: Glucocorticoid effects on immune cells.

Cell type	Effect
Lymphocytes	Reduce circulating numbers
	Inhibit proliferation /activation (by inhibiting IL-2 and other cytokines)
	Induce lympholysis through apoptosis
	Suppress natural killer cell activity
Monocytes	Reduce circulating numbers
	Inhibit secretion of IL-1, IL-6, TNF- $\alpha$ , and monocyte chemotactic activating factors
	Impair synthesis of collagenase, elastase, and tissue plasminogen activator
Eosinophils	Reduce circulating numbers
	Reduce survival (reduce endothelial GM-CSF release)
	Reduce endothelial adherence (by IL-1 inhibition)
Basophils	Reduce circulating numbers
	Impair histamine and leukotriene release
	Inhibit mast cell expansion
	Reduce endothelial adherence
Neutrophils	Increase circulating numbers
	Reduce chemotaxis (decrease IL-1, IL-8, and leukotriene B4)
	Reduce endothelial adherence

Source: [41]

## 6. An Indicator of Reproduction Performance

### 6.1. Service per conception

Reproduction performance can be measured by a major variable such as service per conception (S/C), Conception Rate (CR), Calving interval (CI) and Days Open (DO). S/C

is the average ratio between the total number of service (artificial examination or intercourse) divided by the total number of conceptions in a population. *S/C* represents the success state of reproduction program that explains the number of insemination services or natural mating needed by a female to the pregnancy or conception. *S/C* is normally between 1.6 to 2.0 [49]. Conception rate is can be obtained by the formula:

$$\frac{S}{C} = \frac{\text{Total sum of service}}{\text{number of prenanat now}} \quad (1)$$

The disturbance of hormonal balance which caused by stress in an animal may result in high *S/C* rate. The impaired function ovarium as a consequence of hormonal imbalance that inhibits the LH secretions. Low LH level in an animal may cause the failure of ovulation. Thus, the service or insemination will fail to induce the pregnancy. Eventually, stress condition in an animal may increase the *S/C* rate.

## 6.2. Conception rate

Conception rate is a ration of a cow's fertility at service [49]. It is calculated by dividing the number of pregnant cows by the total number of inseminations. Conception rates are confounded by such factors as the physiologic fertility of the cow, semen quality, and semen handling and insemination techniques. It is not an easy variable to improve; healthy uterus is one of the most important variables to increase the CR.

Conception rate is one of the indicators of assessing reproductive performance. CR can be affected by the physiological state of the reproductive tract. The stress animal can present the impair immune system and reproductive physiology. Therefore, cow fertility may not in a good state. The CR in a stressed animal will be reduced as a result of the failure of conception.

## 6.3. Calving interval and days open

Calving interval (CI) is the distance between two successive births. There are three periods in CI, the gestation, post-parturition anestrus and post-service period. CI is influenced by lactation, post-parturition estrus, quality of estrus detection, insemination techniques, and the success of pregnancy. It aims to show how close a cow or a herd of cows to reach the optimal CI value, which is 365 d. Days Open (DO) is a period or interval of cows after birth to be mated back to the occurrence of pregnancy. DO is longer than 85 d to 115 d after birth [50, 51]. Both DO and CI is dependent on hormonal balance. Therefore, if there is an impairment in ovarium, the hormonal balance will be disturbed. FSH and LH

secretion may decrease because of the inhibitory activity of increasing glucocorticoids level which induced by stress

## 7. Conclusion

Reproduction is a complex physiological system which influenced by hormonal balance and individual immunity. Management practices to alleviate undesirable stress involves a good implementation of animal welfare. Deprived practical of animal welfare in cattle farming can cause the animal suffering from stress. The bad environmental condition such as overpopulation, extreme temperature, and discomfort will give a bad impact on the physiological system in an animal. Physiological and psychological stress that induced by bad management practice and bad animal welfare implementation may alter the hormonal metabolism, moreover depressed the immune system. The secretion of adrenocorticotrophic hormone (ACTH) and cortisol hormone may induce ovarian cycle disorder and depressing immunity of the uterine tract. The high risk of those disorders may cause bad reproduction performance indicator which is increasing the S/C rate, reduced CR, prolong DO and CI.

To maximize reproductive efficiency, the normal state of the animal should be maintained. The fact that stressors can be harmful to the animal's reproduction system, minimizing stress by applying the animal welfare practices in beef cattle may be the best solution. Animal welfare will give a positive impact on the animal well-being as both animal's physiological and physical needs has fulfilled. The authors suggest that good animal welfare practices as stress management in beef cattle are expected to overcome the reproduction problems and enhance the animal's immunity. In conclusion, good animal welfare practices may prevent the occurrence of reproduction problem and improve the beef cattle reproduction through better animal health.

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