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Effects of Human Interaction and Housing Management on Pig Welfare and Performance: A Literature Review

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Abstract*—Pig farming has become a profitable business globally, driven by the increasing demand for pork meat. However, intensive pig farming practices often neglect animal welfare, leading to the deprivation of natural behaviors and causing stress and abnormal behavior. This review paper focuses on how housing systems and human-animal interactions affect pig behavior and performance, as well as the measurement of animal welfare through performance, hormone levels, and meat quality. Understanding animal behavior is crucial for stockmen to respond effectively to animal needs. Various gestures, vocalizations, and movements indicate positive or negative emotions in pigs. The affective state of individual pigs can influence the behavior of their conspecifics, leading to emotional contagion. The role of handlers and their interactions with pigs significantly impact animal behavior and welfare. The socio-demographic background of stockmen, including their attitudes and knowledge, influences animal performance and welfare. Positive human contact, including gentle handling, can counteract stress and fear reactions among pigs. Conversely, aversive handling, such as refusing physical interaction or using threatening postures, negatively affects pig performance. Housing management also plays a crucial role in pig behavior. Unacceptable housing conditions, with a lack of enriched environments, restrict pigs from expressing their natural behaviors, leading to boredom, aggression, and abnormal tail-biting. The type of flooring system used, such as concrete slatted floors, can affect pig welfare and health. Furthermore, the deprivation of maternal behavior in sows can have negative implications for piglets. Enhancements in housing systems and human-animal interactions can significantly improve pig welfare and performance in intensive pig farming.*

***Keywords*—** *Animal behavior, Meat Quality, Pig Farming, Welfare of Pigs*

I. INTRODUCTION

Pig farming is well known as a profitable and popular business in different parts of the world. The world population consumption of pork is around 40.4% in the year 2017, 32.4%, 21.8%, and 5.3% of chicken meat, beef, mutton, and goat respectively (USDA, 2017). There is an evident continuous increase in the demand for pork meat with the increasing human population. The total world population exceeds 7.63 billion at present, and this number continues to grow each day (PRB, 2018).

The rapid increase in demand for pork resulted in the intensive swine raising, that somehow sacrifices the welfare of the animals. Most farm manager works towards how they can increase their production and profit, neglecting the welfare of the animals. This practice resulted in the deprivation of the animals from performing their natural behavior like nesting, roaming, and foraging (USDA, 2012). Motivation and innate behaviors are important aspects of natural behavior, and hindering them may lead to abnormal behavior and stress that has a counterpart in their performance.

Researchers define welfare in different ways, but it was summarized by The Farm Animal Welfare Council of the United Kingdom into 5 categories called Five Freedoms that animals should have: (1) freedom from thirst, hunger and malnutrition (2) freedom from discomfort (3) freedom from pain, injury and disease (4) freedom to express normal behavior (5) freedom from fear and distress (FAWC, 2009).

Improper housing management and the absence of humanly animal interactions violate these five freedoms of the animal which causes abnormal behavior that translates into injuries, poor growth performance, cannibalism, aggression, animal restlessness, and fear (Koene, 2017). Careful, quiet handling of livestock by trained people in good facilities will reduce bruising and other injuries that will result in quality meat.

This review paper will be focusing and further elaborate on how the housing system and human-animal interactions affect animal performance and behavior. In addition, this paper will dwell on how we can measure the welfare of the animals based on performance, hormone levels, and meat quality of the animals.

II. LITERATURE REVIEW

A. Understanding Animal Behavior

For a stockman to be responsive to the needs of the animals, there should be an understanding of the common behavior among animals. Animal behavior can be recognized as expressions that require either immediate attention or satisfaction and comfort which can be demonstrated by bodily movements, vocalizations, and temper among others. This can be observed in both either resting or active state and day or night. It now lies in the promptness of the stockman that will dictate the fate of the animals given various displays of animal behavior.

Effect on Individual Pigs. For instance, tail wagging is an indicative gesture of positive emotion such as social greeting (Worthington, 1976 and Terlouw et. al., 2005), eating (Kleinbeck et. al., 1993), and being playful or showing

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exploratory behavior (Newberry et. al., 1988; Boissy et al., 2007; and Held and Spinka, 2011). It is also worth mentioning that tail wagging is not always an indicator of positive emotion but could also be a sign of irritation (Worthington, 1976) in some cases as shown after tail docking (Noonan et. al., 1994), after castration (Hay et. al., 2003), or due to tail biting (Zonderland et. al., 2009). Ear movements could also be an indicator of negative emotions as proposed by Reimert et al, 2013) when they exposed pigs to an aversive event. Changes between the ear posture front and back as well as ear back are seen frequently during the conduct of the experiment. Snout orientation can also be an implication of negative emotion, particularly frustration. According to Dantzer et al., (1987) and Lewis, (1999), animals will likely experience frustration if there is failure to express their desired behavior or motivation is prevented by physical or psychological obstacles. In a study conducted by Terlouw and Porcher (2005), pigs that were subjected to refusal of contact tend to orient their snout towards the floor upon seeing a person from a distance which indicates a frustrated gesture as a result of psychological hindrances, that is - fear. Moreover, high-pitched vocalization especially during handling (Warris et al, 1994), immobility (Terlouw et al, 2005), flight, peeing, and defecating can also be considered as an expression of negative emotion and physiological stress in pigs exposed to an aversive setting.

Effect on Group-Housed Pigs. The welfare state of an individual pig might affect the behavioral state of its conspecifics, especially in times of distress or displeasure (Reimert et al., 2013). The affective state of the surrounding conspecifics could lead to emotional contagion or a simple form of empathy as seen in situations such as routine handling procedures, transport, and slaughter of animals (De Waal, 2008 and Langford et al., 2006) as well as in a state of pleasure (Held et al., 2011). Emotional contagion could either ameliorate or diminish animal welfare (Spinka, 2012), health (Amory et al., 2000; Vieuille-Thomas et al., 1992; and Hemsworth, 2003), and performance (Hemsworth, 2003).

B. Role of Handlers and Their Effect on Pig's Behavior and Welfare

The productivity and welfare of animals in an intensive farming system are influenced by interactions between the handler and their animals (Hemsworth and Coleman, 1998). Studies suggest that humans may either contribute to predictors of positive events or negative events in the lives of animals (Hemsworth et al, 2011 Davis & Taylor, 2001). According to Waiblinger et al (2006), interaction may be in the form of visual presence, vocal sounds, physical contact, and reward system (eg. feeding). On the other hand, interaction may be in the form of invasive handling. Moreover, the magnitude of human-animal interaction may vary from frequent yet gentle and friendly to seldom but aggressive approach (Hemsworth & Coleman, 1998 and Waiblinger et al 2002).

Socio-Demographic Background of the Stockman. Pig productivity, welfare, and behavior are largely influenced by the stockman's skills, knowledge, and attitude he possesses in fulfilling his job caretaking of animals. So far, numerous studies in the past demonstrate the importance of the socio-demographic background of the stockman in the performance of the animals. Stockmans' attitudes are translated in their behavior toward animals which impacts animal behavior, welfare, and productivity. Research shows that negative attitudes toward animals can result in negative handling and reduced welfare (Hanna et al., 2009; Hemsworth et al., 1994). Conversely, Austin and colleagues (2005) stated that open-minded farmers are expected to seek and uphold information concerning animal welfare which can be seen as key to increased performance and productivity via animal welfare. Coleman (2001) suggests that technical knowledge through training is essential as it creates awareness among stockmen regarding empathy attribution towards animals that would ultimately improve animals' welfare. The work of Coleman (1998) and Crawford (2011) proved that a high level of education is unnecessary in animal husbandry as it does not affect production as long as dutifulness, tenaciousness, and sensitivity is being observed (Coleman, 2008). Meanwhile, it was also proven that women are very compassionate towards animals and are very particular about humane treatment whereas men are considered to be production-centered, although views are overlapping (Furnham et al., 2003; Heleski et al., 2004; Lensink et al., 2000). The study of Serpell (2005) further reveals that gender was the most significant predictor of humane attitudes to animals with females having more positive attitudes than males. In addition, the study of Paul and Podberscek, 2000) has shown that female Veterinary Medicine students were able to maintain their level of affective empathy (their ability to share in the emotions of another) throughout their studies compared to males where levels of empathy are low.

Effects of Positive Contact. Hemsworth et al (1981) explained that frequent positive human contact is a very effective tool to counteract stress and fear reactions among pigs. It is also noteworthy to mention that piglets can recognize handlers who observed gentle handling techniques. This means that piglets will positively react to the presence of a familiar handler compared to those they are not acquainted with (Somavilla et al 2011; and Tanida & Nagano, 1998). In a study by Hemsworth and Barnett (1992), they have proven that the early stages of pigs can be described as a sensitive period for socialization. They explained that pigs have shown less fear towards human handlers towards the fattening stage (about 18 weeks of age) when they were socialized with gentle handlers for 3 weeks postpartum compared to those piglets socialized at a later stage. Also, Brajon et. al., (2015) reported that piglets can retain memories for up to 4 weeks following exposure to either positive or negative experiences. Therefore it is necessary to provide a positive experience for piglets at first handling since their memories can last for a month. Moreover, according to Day et al (2002), gentle handling at early life stages may have a carry-over effect in terms of feed intake during the growing period. It also reduces fear reactions in human approach tests and is easier to handle later in life (Hemsworth and Barnett, 1992 & Oleiveira et al, 2015). However, Day et al (2002) claimed that pigs were more

difficult to move during transfer and other routine tasks when they were used to be handled pleasantly. Furthermore, pigs that experience tactile stimulation tend to have an increased affinity and prolonged interaction toward unfamiliar humans compared with non-handled ones (Tanida et al., 1995; Tallet et al., 2014; and Oleveira et al., 2015).

Effects of Aversive Handling. Refusal to have at least physical interactions or simple eye contact with the pigs as a form of aversive handling implies a negative effect on the performance of pigs (Terlouw and Porcher, 2005). Creating heightened tones, threatening postures, and constraining piglets towards the creep area throughout the suckling period are being perceived aversively by piglets which results in increasing avoidance of their handlers. Additionally, Henry et al (2006) and Laurence et al (2014) have explained that rough handling in piglets may persist for a long period and incur consequent reluctance and likely fear of human handlers..

C. Housing Management Affects Pigs Behavior

In intensive livestock production which focuses mainly on high productivity and profit, unacceptable housing conditions are common due to restriction and space maximization (Fraser, 2008). Most of the pig production systems are operated in industrial confinement compromising animal welfare and ignoring the scientifically proven indicators relating to pigs' state of being. Industrial pig production facilities tend to have a barren, nonexistence of enriched, interesting environment that would prohibit the pigs from expressing their natural behaviors or redirecting their natural curiosity to other pigs.

Absence of Foraging-Related Activities. Research shows that pigs placed in an enclosed forest area spent 50% of their daily activities in foraging-related activities (Stolba and WoodGush, 1989). However, in the absence of a foraging area, Van Putten (1969) reported that the ears and tails of pigs are the easiest targets among their pen mate. Nosing or biting each other is the most common occurrence or simply spending more time inactively (Beattie et al., 2000; Beattie et al., 1995) which are indicators of poor welfare associated with lack of stimulation and boredom (WoodGush and Beilharz 1983). Abnormal tail-biting is the common behavior expressed by the pigs subjected to this type of environment (Smulders, 2008) which typically starts with one pig playing with, sucking, or chewing until it escalates to tail biting (Blackshaw, 1981) resulting in an acutely painful injury to the tail base, abscess, and systemic infection (Kristass and Morrison, 2007 ; Gregory, 2007). Prolonged and severe cases may lead to hindquarters may be bitten and tail biting can escalate into cannibalistic behavior (Blackshaw, 1981). Preventive measure such as tail docking is the usual approach shortly after birth. However, too short tails result in pigs biting the ears of their pen mate instead (Goossens et al., 2008) which could result in ear hematoma (Blackwell, 2004). Provision of straws, hay, and other enrichments would largely reduce or even prevent tail-biting behavior (Blackwell, 2004; Moinard et al., 2003; Guy et al., 2002; and Day et al., 2003). Artificial enrichment such as rubber tires, chains, and footballs tend to lose their novelty over time because they do not fulfill all the foraging components such as investigation, manipulation, and consumption (Zonderland et al., 2004).

Effect of Type of Flooring System. Past studies confirmed that pigs favor earthen floors rather than concrete (Van Rooijen, 1982). Results of the British survey of indoor and outdoor pig farms published in 2008 showed that foot and limb injuries were less in reared outdoors compared to confined indoors on concrete-slatted flooring (Kilbride, et al., 2008) with inflamed, fluid-filled, saclike structures between tendon and bone. The design of the flooring must be suitable for the size and weight of pigs so as not to cause injury or suffering. Slatted floors are widely used in modern pig production because it offers benefits to pig's health, hygiene, and a reduction in cleaning time. However, pigs are at risk of lameness and a variety of foot problems, therefore, the surface on which they are kept is a key feature affecting their welfare. Backstrom (1973) has reported that the initial introduction of slatted floors in production facilities has led to hoof disorders such as foot lesions. To reduce the incidence of these risks associated with slat flooring and promote better welfare among pigs kept on a commercial scale, the table below could be used as a guide in the construction of slatted floors in pig pens.

TABLE I. Specifications for Concrete Slatted Floor

	Maximum gap between slats (mm)	**Maximum slat width (mm)**
Piglets	11	50
Weaners	14	50
Rearing	18	80
Gilt post-service and sows	20	80

Source: The Welfare of Farm Animals (England) (Amendment) Regulation (2007)

Deprivation of Maternal Behavior in Sows. Naturally, during the prepartum stage, the sow performs the nest-building behavior accompanied by foraging, rooting and pawing which resembles their desire to build a shelter for their offspring (Wischner et al., 2009). However, farrowing crates have been widely adopted to avoid piglet crushing and mortality ensuring survivability. This creates a conflicting view with the animal welfare scientist pointing out that it greatly affects maternal behavior thereby inducing stress and frustration in the sow (Jarvis et al, 2004 and Thodberg et al., 2002) and this is evidenced by the production of stress hormone such as cortisol. When sows are in stressful conditions, oxytocin production is hampered due to increasing cortisol levels thereby prolonging the parturition period (Lawrence et al., 1992) posing a risk to piglets being stillborn. Although oxytocin administration is common when the sow is experiencing difficulty in farrowing, improper oxytocin use can also cause an increased number of stillbirths by causing ruptured umbilical cords that lead to decreased oxygen delivery to the piglet during birth (Lineen et al., 2009).

Social Dominance and Aggression. Overcrowding is the prevalent scenario in an intensive production system where pigs roaming area are limited which negatively influence social interaction. Fighting is common among newly sorted pigs especially when one pig is singled out by multiple

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aggressors resulting in injuries (Blackwell, 2004). Social dominance is then established with superior pigs getting most of the feed, space, and comfort whereas the inferior ones will likely suffer from lameness and fear. Additionally, the flight response of pigs subjected to aggression is less effective due to limited space (Jensen and Wood-Gush, 1984) unlike confinements with sufficient space where pigs can avoid such situations thereby reducing the instances of antagonistic interactions (Stolba and WoodGush, 1989; Jensen and Wood-Gush, 1984). Table II below shows the recommended floor space for pigs kept in industrial pig production facilities.

TABLE II. Recommended floor space for pigs in commercial scale

Average Weight	Min. space/pig (m2)
Up to 10 kg	0.15
10-20	0.2
20-30	0.3
30-50	0.4
50-85	0.55
85-110	0.65
More than 110 kg	1.0

Source: The Welfare of Farm Animals (England) (Amendment) Regulation (2007)

D. Stress Response Due to Poor Welfare as Seen in Pigs

The definition of welfare is still subject to debate among animal welfare scientists because the perception of this could differ from person to person (Hewson, 2003). According to Dawkins (2008) in his simple definition, good welfare exists when an animal is well provided and is healthy. However, in the broader context, the Welfare Quality (2009) interprets "welfare" in 12 criteria such as the absence of prolonged hunger, absence of prolonged thirst, thermal comfort, comfort around resting, ease, absence of injuries, absence of disease, absence of pain induced by management procedures, expression of social behavior, expression of other natural behavior, good human and animal relation and positive emotional state of movement. The Farm Animal Welfare Council of the United Kingdom defined welfare through the Five Freedoms that animals should have: (1) freedom from thirst, hunger and malnutrition (2) freedom from discomfort (3) freedom from pain, injury and disease (4) freedom to express normal behavior (5) freedom from fear and distress. According to Boissy and Veissire (2007), welfare is associated with stress wherein stress is the result of compromised welfare. Stress is a situation where an animal cannot adapt to stimuli and incidents in its surroundings such as challenges concerning the social environment, housing conditions and feeding (Einarsson et al., 1996; Arey and Edwards, 1998), without major hormonal or behavioral adjustments (Moberg, 2000).

Physiological Response to Stress. The behavior expressed by the animals upon exposure to an aversive event is the result of their physiological response. Grandin (1997) pointed out that animal discomfort can be precisely measured through the behavioral and physiological approach. The crucial role of the brain in adaptation and stress mechanisms has been widely acknowledged. Homeostasis or a stable state within the animal system is maintained through the action of the central nervous system which gathers information via sensory organs either externally or internally. This information serves as an indicator of threat or danger as related to personal expectations, experience and opportunities for control; finally, it instigates the adaptive responses, which include behavioral adjustments and neuroendocrine changes to meet the energy requirements for the behavioral response and to maintain homeostasis (Dantzer and Mormede, 1983). Psychological aspects of environmental stimuli are powerful activators of endocrine responses.

Hormones as Stress Indicator. The amount of psychological stress that animal experiences determine how much the pituitary-adrenal axis responds. Selye (1955) and Siegel (1985) divided the physiological response into three periods such as alarm, resistance, and exhaustion. Alarm and resistance occur when stress factors induce stimulation of the hypothalamic-pituitary system that causes the release of corticotrophin-releasing factor which subsequently causes the release of adrenocorticotropic hormone (ACTH). ACTH hormones enable the adrenal glands to release cortisol above the normal level. The increase in cortisol level also increases glycogenolysis, blood pressure, and mental activity as well as mobilization of fatty acids from adipose tissues. Determining cortisol concentration in the blood is the common method used to indicate stress. However, Moberg (2000) pointed out that measuring stress through cortisol levels in saliva or blood is not a reliable indicator of stress unless done in controlled experimental conditions. Assessing cortisol level requires capture, handling, and bleeding of animal that causes an abrupt increase in blood glucocorticoid concentrations within 3 minutes (Sheriff, Krebs, & Boonstra, 2010) which confound the result. For this reason, Sheriff et al., (2010) proposed the use of fecal samples in measuring cortisol levels which is more advantageous since it can be easily collected without stressing the animals. Such a study showed comparable results using fecal samples and plasma cortisol levels.

Stress factor induces the release of epinephrine from the medulla of the adrenal gland. This hormone increases body temperature, respiration rate, and depth (Yurdakos, 2005). The duration of the aforementioned physiological events takes place momentarily or in a long duration. This mechanism benefits the animal in managing stress. However, when there is prolonged exposure to a stressor (high cortisol concentration), the body mechanism becomes insufficient thereby resulting in exhaustion (Yurdakos, 2005). Exhaustion period decreases performance, susceptibility to diseases and growth retardation. Severe chronic long-term stress can result in increased body temperature, immunosuppression, and hypertension (Nelson, 1995). As the animal recovers from the stressful condition, they are becoming vulnerable to acquiring diseases (Crawford 2011).

Additionally, long-term stress has an impact on reproduction hormones and their function, especially during ovulation, heat and early pregnancy (Lang et al., 2003; and

Turner et al., 2005). Reduced piglet survival can result from behavioral and hormonal changes during parturition and early lactation, periods that are sensitive to stressors, as reviewed by von Borell et al. (2007).

Effect on Production Performance. Any stressful condition has the potential to cause a decline in the performance parameters of pigs, including reduced feed intake, daily weight gain, and overall body weight. (Table III). White et al. (2008) have revealed that pigs housed at 32.2°C had a 32.3% decrease in average daily feed intake, 39.3 % lower ADG, 9.8 % lower final body weight and a 16.3 % lower gain: feed (G:F) ratio compared to pigs housed at 23.9°C. Pearce et al. (2013) have also affirmed that feed intake decreased by up to 47% in pigs housed at temperatures above the thermo-neutral zone. Similarly, Hyung et al. (1998) found that growth rates were reduced by 15.7% and 7.1% as a result of crowding and mixing, respectively, and showed a decrease in ADG and G:F of about 15% and 10%, respectively, when the space available per pig was reduced from 0.56 to 0.25 m2/pig. Additionally, Lee et al. (2005) likewise found that weaned pigs housed in a clean environment consumed about 8% more feed and grew faster (about 10%) than those housed in a dirty environment.

TABLE III. Specifications for Concrete Slatted Floor

Parameter Affected	Stressful Stimuli	Decrease, %	Reference
ADFI	Heat stresses	32.3	White et al.(2008)
		47.0	Pearce et al.(2013)
	Dirty environment	8.0	Lee et al.(2005)
ADG	Heat Stresses	39.3	White et al.(2008)
	Crowding	15.7	Hyung et al.(1998)
	Decrease space availability	15.0	Hyung et al.(1998)
	Dirty Environment	10.0	Lee et al.(2005)
BW	Heat Stress	9.8	White et al.(2008)
	Shipping (4 h)	2.9	Hicks et al.(1998)
G:F	Heat Stress	16.3	White et al.(2008)
	Decrease space Availability	10.0	Hyung et al.1998)

**ADFI – Average Daily Feed Intake, ADG – Average Daily Gain, BW- Body Weight, G:F – Gain:Feed Ratio*

Effect on Reproduction. In instances of stress, a detrimental impact on the reproductive system of boars has been observed, leading to diminished ejaculate volume and compromised semen quality. In contrast, gilts and sows show fewer born piglets per litter and reduced rebreeding rate, as well as irregular rebreeding, and higher weaning-to-oestrus interval (Einarsson et al., 2008) leading to a fall in farm production parameters when exposed to stress.

Effect on Meat Quality. Furthermore, the impact of stress extends to meat quality, leading to a higher occurrence of pale, soft, and exudative (PSE) as well as dark, firm, and dry (DFD) meats. These conditions serve as clear indications of subpar meat quality. attributed to stressful handling before slaughter (Warris, 1998). PSE is due to the rapid breakdown of muscle glycogen rendering meat to becoming very pale with pronounced acidity (pH values of 5.4-5.6 immediately after slaughter) and poor flavor. Most type of this meat product is not preferred by butchers or meat processor and in extreme cases categorized it as waste. PSE can be significantly reduced when pigs are given an hour for rest before slaughter (Gebregeziabhear, 2015). On the other hand, DFD is similar to PSE except for a little lactic acid production due to the remaining glycogen in the muscle of the meat. This particular meat exhibits inferior quality since its less pronounced taste and darker color are less appealing to consumers. Additionally, its abnormally high pH value results in a shorter shelf life.(6.4-6.8). DFD meat is the manifestation of a carcass coming from a stressed, injured, or diseased carcass before slaughter (Gebregeziabhear, 2015).

III. Conclusions

The studies explore the effects of human interaction and housing management on the welfare and performance of pigs. Neglecting animal welfare in favor of increased production can lead to abnormal behavior, stress, and negative effects on performance. Understanding animal behavior is crucial for stockmen to respond appropriately to their needs. Positive human contact, such as gentle handling, has been found to reduce stress and fear in pigs. On the other hand, aversive handling can have negative effects on pig behavior and performance. Inadequate housing conditions, such as a lack of foraging opportunities and inappropriate flooring systems, can compromise pig welfare. The review emphasizes the importance of considering animal welfare in pig farming practices for improved performance and overall well-being.

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