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Maladaptive Behaviours In Farm Animals-A Review Paper

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Review Article

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Abstract

Maladaptive behaviors are diverse repetitive, pointless or harmful actions that are performed by normal animals in abnormal environment. They may also be defined as individual or social actions that are destructive, disturbing and compromising to physiological, psychological and general well-being of livestock. They are also defined as untypical reaction to a particular combination of stimuli. Maladaptive behaviors usually occur when an animal is in a stressful or unsuitable environment often due to confinement or poor management. They may also be indicators of underlying illness or psychological distress. These usually develop as a mechanism of coping to stress, frustration or lack of species-specific environment. These behaviors usually differ in pattern, frequency and context in which certain species employ them. Before the identification of the abnormal behaviors, the normal way of behaving in the various species must carefully be studied. Some contributing factors to these behaviors as identified in various literature include; overcrowding of animals, lack of certain nutrients in the diet, isolation, underlying health issues, mimicry, maternal deprivation in early stages of life, genetics, temperament, among others that will be discussed broadly later on in this review. Furthermore, maladaptive behaviors are classified into, stereotypies, compulsive, redirected, displacement behaviors depending on the factor triggering it. Examples of such include; cannibalism, feather-pecking in poultry, tail and ear biting in swine, chewing objects and bar-biting in goats, tongue-rolling, licking and biting of random objects in cows, hair-pulling in donkeys, among others. This review paper focuses on the forms of maladaptive behaviors in various animal species, their predisposing factors, their identification and how best they can be managed to maintain optimum productivity. It also synthesizes current knowledge, underlying mechanisms, species-specific manifestations and evidence-based management strategies.

Keywords: Maladaptive; Stress; Adaptation; Normal; Abnormal

Introduction

Maladaptive behaviours in farm animals are detrimental actions that deviate from natural behavioral patterns, often arising from environmental stressors, inadequate management, or poor welfare conditions [1]. They can also be defined ad actions that deviate from the natural behavioral repertoire of animals often rising from an inability to adopt to environmental stimuli [2]such as colic, ligament strain, and incisor wear. Relatively little is understood about the etiologies of oral and locomotor stereotypies. Seemingly disparate causal factors have been proposed, including gastric pathology, neural adaptation, and genetic predisposition. In this review, we propose a model of causality that presents

separate pathways to the development and continuation of oral behaviors such as crib-biting, compared with locomotor alternatives (i.e., weaving. They are diverse expressions of abnormal or dysfunctional actions that arise when animals face environmental conditions that fail to accommodate their physiological and psychological needs [3]. They are also referred to as abnormal behaviours, behavioral disorders or stereotypic behaviours. They are critical indicators of compromised welfare and are often associated with environments that lack opportunities for natural behaviours or those that impose chronic stress [4]. These not only compromise animal welfare but can also lead to economic losses due to reduced productivity and increased veterinary costs [1]. They are very common in intensive livestock production systems. Historically, interest in maladaptive behaviors began in laboratory animals but the work of Fraser, et al. expanded the field to domestic livestock. Understanding the underlying causes and manifestations of these behaviors is crucial for developing effective management strategies [5]. Causes are typically multifactorial in that they may be due to diet-related reasons like inadequate diet or poor forage structure nutritional deficiencies or imbalances, barren environment and lack of enrichment [6]. They may also be due to high stocking density management and management practices such as are you.

Theories Underlying Occurrence of Maladaptive Behaviours

There are three theories that explain the emergence of maladaptive behaviors

Frustration Theory

This theory suggests that maladaptive behaviors arise when animals are unable to perform natural behaviors due to various environmental constraints which leads to frustration and stress. An example is when sows in gestation crates begin bar-biting due to inadequate space and inability to move.

Coping Mechanism Theory

As suggested by this theory, maladaptive behaviors are a way for animals to cope with stress, anxiety or boredom for instance, feather pecking in chickens may be a way to deal with stress or overcrowding. It is also referred to as stress theory. It was suggested by Broom.

Malfunctioning Brain Theory

This theory proposes that maladaptive behaviors result from genetic or environmental factors that affect brain development and functionality. A case is that feather pecking may be more common in some breeds of chicken than others due to different genetic factors.

Classification of Maladaptive Behaviours

Stereotypic Behaviors

Stereotypies, or stereotypical behaviors, are generally defined as repetitive behaviors that are not functional or have no purpose [7]. When an individual is struggling to cope in a human-controlled environment that is not meeting their needs, they may develop stereotypic behaviors such as pacing, weaving, plucking feathers or biting themselves, chewing on fencing or gates, cribbing (Cribbing is a stereotypy seen in horses when an individual bites onto a surface like a post or a fence with their front teeth and flexes the muscles in their neck while pulling back which generally produces a grunting sound) [8], rubbing one's head or another body part on various surfaces, rolling eyes, biting or other harmful behaviors directed at others or themselves, or tongue-rolling.

The main thing to note about stereotypies is how unvarying they are in their particular patterns. Any sign of repetitive behavior that doesn't serve a purpose should serve as a red flag. Caregivers should take a closer look and try and determine what might be causing an individual to struggle to cope in their environment. A physical health check is important, as well as determining what possible environmental or other management factors might contribute to their stress.

Redirected Behaviors

These occur when animals redirect natural behaviours towards inappropriate targets due to frustration or lack of stimulation. Examples include:

- Feather Pecking in Chickens: Redirected from dust-bathing behavior.
- Tail Biting in Pigs: Often a response to social stress or boredom.

Abnormal Social Behaviours

Altered social interactions can manifest as:

- **Aggression**: Increased fighting due to overcrowding or poor social structure.
- **Isolation:** Withdrawal from group activities, indicating stress or illness.

Compulsive Behaviours

Compulsive behaviors are also abnormal repetitive behaviors. These behaviors may vary in their presentation and can be thought of as stereotypies that stuck even after changing the environment. When a stereotypy becomes disconnected from the original causal factor, it might be considered a compulsive behavior.

Displacement Behaviours

Displacement behaviors may appear out of context in a situation. Situations where an individual feels conflicted between two competing motivations or when an individual is frustrated by an inability to perform a desired behavior, can lead to a displacement behavior.

This is an example of displacement behavior because the behavior, preening, has nothing to do with the motivations of the individual and is out of context in this situation.

Species-Specific Maladaptive Behaviours

Cattle (Dairy and Beef)

Manifestation: Tongue-rolling, excessive mounting, bar licking, self-sucking, cross-sucking in calves and aggression at feeding stations.

- **Risk factors:** feeding regime (restricted access, low roughage in diets), early separation from dam, indoor confinement, inadequate feeding management (frequent concentrate feeding), and social isolation. Improved roughage provision, feeding methods allowing longer feeding times and social housing reduce incidence [4].
- **Contributing factors:** Restricted feeding, low-fibre diets, early weaning, overcrowding, and lack of roughage.

Small Ruminants (Sheep and Goats)

- **Manifestation:** Wool pulling, flank sucking, fence chewing and oral stereotypies reflecting oral frustration or itch.
- **Risk factors:** mineral deficiencies (pica), parasitism inducing pruritus, isolation, and barren paddocks. Correcting nutrition, reducing parasites and providing appropriate foraging reduces problems. (See classical pica/litter-eating literature).

Pigs

Pigs show the highest incidence of maladaptive behaviours under intensive production

- **Manifestation:** Tail biting ranges from gentle manipulation to severe chewing that causes wounds, infection and necrosis. Other oral stereotypies include bar-biting and sham-chewing.
- **Risk factors**: barren flooring, lack of manipulable substrate (straw, rooting material), overcrowding, dietary composition (low fibre), high stocking density, abrupt mixing, poor ventilation, and genetic predispositions. Prevention is multi-factorial: enrichment (substrate, objects), dietary fibre increase, proper stocking densities and careful management during regrouping [9].

Poultry

- **Manifestation:** Feather pecking (gentle vs severe) can escalate to cannibalism and high mortality; vent pecking and aggressive pecking are also notable.
- **Risk factors:** genetic lines, light intensity and schedule, protein and amino acid balance, early rearing environment, lack of foraging substrate, high stocking density, and nutritional deficiencies (e.g., low tryptophan). Management strategies include genetic selection for low pecking lines, environmental enrichment (pecking objects, litter), optimized light programs, and dietary adjustments.

Horses

- **Manifestation:** Oral stereotypies (crib-biting, wind-sucking), locomotor stereotypies (weaving, box-walking), and wood chewing.
- **Risk factors:** stall confinement, social isolation, high concentrate diets, limited turnout or exercise, early weaning, and stressful training regimens. Providing turnout, social contact, forage-based diets and environmental complexity reduces prevalence.

Predisposing Factors to Occurrence of Abnormal Behaviours

Environmental Stressors

Factors such as inadequate housing, poor ventilation, and lack of environmental enrichment can lead to stress, triggering maladaptive behaviours.

Management Practices

Confinement systems that limit space, movement, and exploration lead to frustration. Overcrowding, early weaning, and lack of social interaction can disrupt natural behaviours, leading to the development of abnormal patterns. Additionally, lack of environmental complexity for example absence of hiding spaces in poultry reduces coping mechanisms for stress fueling abnormalities in normal behavior.

Also delay in provision of feeds or drinks and picking of eggs for cases of poultry encourages abnormality due to hunger for example cannibalism and egg eating respectively. Stressful handling: Rough or frequent handling can cause stress and lead to maladaptive behaviors. Inadequate socialization in form of Isolation or lack of social interaction can affect animal behavior. Inconsistence in routine or management practices can cause stress and anxiety.

Genetic and Physiological Factors

- **Genetic predisposition:** Genetics can play a role in the development of stereotypies. In some cases, certain breeds are more prone to certain abnormal behaviors than others. The health and stress of the mother while pregnant can increase the risk of their offspring developing certain behavioral traits. Highly productive farm animals are more prone to maladaptive behaviours due to disproportionate genetic selection favoring production traits over adaptive capacities.
- **Hormonal imbalances:** Hormonal changes or imbalances can influence behavior
- **Brain chemistry:** Imbalances in neurotransmitters like serotonin can contribute to abnormal behaviors.

Health-Related Factors

- **Pain or discomfort**: Untreated pain or discomfort can lead to abnormal behaviors.
- **Disease or illness:** Certain diseases or illnesses can cause changes in behavior.

Dietary

Diets that lack the appropriate nutrients, "bulk," and amount can be a causal factor in developing abnormal behaviors. Additional dietary factors include the number of times an individual is fed and whether their diet allows them to perform natural behaviors for an appropriate amount of time. For example, concentrate diets are typically gobbled up quickly, leaving residents unable to carry out their normal foraging behavior that may naturally take them many hours over a day (*Tryptophan in Poultry Nutrition: Impacts and Mechanisms of Action - Fouad - 2021 - Journal of Animal Physiology and Animal Nutrition - Wiley Online Library*, n.d.).

These factors can interact and contribute to the development of maladaptive behaviors in farm animals.

Deprivation of mother And Early Life Experiences

The absence of normal maternal care in mammals may lead to abnormal oral behaviours. A lack of normal parental presence and care may affect how individuals manage stressors.

Mimicry

There is some evidence in certain species that an individual may learn a stereotypy by observing a herd or flock mate.

Temperament

Different individuals have different ways of behaving. Someone with a particular temperament may be more prone to developing certain abnormal behaviours. Suppose you have an outgoing, energetic resident. In that case, they may struggle more quickly or intensely with confinement or isolation. In contrast, someone who is timid may struggle when living with too many residents for the space or with a lack of control over being able to remove themselves from unwanted interactions [10].

Physiological And Neurological Mechanisms

The physiological and neurological mechanisms underlying maladaptive behaviours in farm animals involve complex interactions between the brain, nervous system and endocrine system. This therefore involves, neurotransmitters and hormones and a series of mechanisms as discussed below;

Neurotransmitters and Hormones

Serotonin: this is involved in regulating mood, appetite and stress response. Imbalances can definitely lead to anxiety, aggression and other related abnormalities. Impulse-related behaviours (feather pecking, aggression) relate to low serotonin turnover [11].

- **Dopamine:** this hormone plays a role in reward processing, motivation and pleasure. Its also responsible for regulating sleep. Irregularities in the regulation or balance of this hormone can ably trigger stereotypies [12].
- **Cortisol;** this is usually released in response to stress and it stimulates the sympathetic nervous function affecting mood, behavior and cognitive function.
- **Oxytocin;** involved in social bonding and stress regulation. Imbalances can influence social behavior and anxiety.

Brain Regions Involved

- **Amygdala:** This processes emotions such as fear and anxiety contributing immensely to various exhibition of behaviour.
- **Prefrontal cortex;** This is involved in decision-making, impulse control and regulating emotions
- **Hippocampus:** plays a role in learning, memory and spatial navigation
- Stereotypies are linked to dopamine sensitivity in the basal ganglia.
- **Gut–Brain Axis:** Nutritional factors influence behaviour through microbiota and neurotransmitter precursors.

Physiological Mechanisms

There are various mechanisms that interact to contribute to development of abnormal behaviors in farm animals. Some of these are discussed below;

Stress response: This is a complex process involving the hypothalamic pituitary adrenal axis, sympathetic nervous system and other pathways. The hypothalamus receives stress signals and activates the HPA axis. The pituitary gland releases adrenocorticotropic hormone in response to the hypothalamic stimulation. The adrenal glands release cortisol and other glucocorticoids in response to ACTH. With the above three hormones activated, the stress response process is initiated. The stress response mechanism is complex, and its dysregulation can contribute to maladaptive behaviors and welfare issues in farm animals. It involves the following processes;

- **Stress perception:** The animal perceives a stressor (e.g., physical, emotional, or environmental).
- **HPA axis activation:** The hypothalamus releases corticotropin-releasing hormone (CRH), stimulating the pituitary gland to release ACTH.
- **Cortisol release:** ACTH stimulates the adrenal glands to release cortisol into the bloodstream.
- **Physiological effects:** Cortisol influences various physiological processes, including:

1. Metabolism: increases glucose release, suppresses immune response
2. Cardiovascular: increases blood pressure, heart rate
3. Behavioral: influences mood, appetite, and behavior

Effects on animal behavior and welfare:

- **Acute stress:** Short-term stress can be adaptive, preparing the animal to respond to the stressor.
- **Chronic stress:** Prolonged stress can lead to negative effects on welfare, including:

1. Immune suppression
2. Reduced growth and productivity
3. Behavioral problems (e.g., anxiety, aggression)

Regulation of stress response:

- **Negative feedback loop:** Cortisol inhibits further HPA axis activity, regulating the stress response.
- **Other factors:** Other hormones, neurotransmitters, and physiological pathways can influence the stress response.
- **Neuroplasticity:** Neuroplasticity refers to the brain's ability to reorganize and adapt throughout life in response to experiences, learning, and environmental changes.

Mechanisms of neuroplasticity:

- **Synaptic plasticity:** Strengthening or weakening of synaptic connections between neurons.
- **Neurogenesis:** Birth of new neurons in certain brain regions.
- **Dendritic remodeling:** Changes in dendrite structure and number.
- **Axonal sprouting:** Growth of new axonal branches.

Keyplayers

Neurotransmitters: Chemical messengers like glutamate, GABA, and dopamine regulate synaptic plasticity.
Growth factors: Proteins like BDNF (brain-derived neurotrophic factor) support neuronal growth and survival.
Hormones: Steroid hormones like cortisol and estrogen influence neuroplasticity.

- **Types of neuroplasticity:**

Short-term plasticity: Rapid changes in synaptic strength.
Long-term plasticity: Long-lasting changes in synaptic strength or connectivity.
Structural plasticity: Changes in neuronal structure, such as dendritic remodeling.
Implications for animal behavior and welfare: Neuroplasticity underlies learning and memory formation. It also enables animals to adapt to changing environments. Chronic stress can impair neuroplasticity, contributing to anxiety and depression-like behaviors. Recovery from injury: Neuroplasticity can aid in recovery from brain injury or disease.

Factors influencing neuroplasticity

- **Experience and learning:** Enriched environments and learning experiences promote neuroplasticity.
- **Age:** Neuroplasticity declines with age, but can be maintained with experience and exercise.
- **Hormones and neurotransmitters:** Hormonal and neurotransmitter imbalances can influence neuroplasticity.
- **Gut-brain axis**: The gut-brain mechanism refers to the bidirectional communication network between the gut microbiome and the central nervous system (CNS). It is composed of; Gut microbiome with Trillions of microorganisms (bacteria, viruses, fungi) living in the gut. Enteric nervous system (ENS) which is a network of neurons lining the gut, often called the "little brain", Vagus nerve which is a major nerve connecting the gut to the brain and Brain-gut axis which is the communication pathway between the CNS and the gut.
- **Mechanisms of gut-brain communication:** Gut microbes produce neurotransmitters (e.g., serotonin, dopamine) that influence mood and behavior. Gut hormones (e.g., ghrelin, leptin) regulate appetite, satiety, and energy balance. The vagus nerve transmits signals from the gut to the brain, influencing mood, stress, and cognitive function. Microbiome-derived metabolites (e.g., short-chain fatty acids) that influence brain function.
- **Implications for animal behavior and welfare:**

Mood and stress: The gut microbiome influences stress response, anxiety, and depression-like behaviors.

- **Appetite and feeding behavior:** The gut-brain axis regulates appetite, satiety, and food preferences.
- **Social behavior:** The gut microbiome influences social behavior, including social interaction and communication.
- **Cognitive function**: The gut-brain axis impacts learning, memory, and cognitive flexibility.

Factors influencing the gut-brain axis

- **Diet:** A balanced diet rich in fiber and diversity supports a healthy gut microbiome [13].
- **Stress:** Chronic stress can disrupt the gut-brain axis and alter the microbiome.

Antibiotics and medications: Exposure to antibiotics and certain medications can impact the gut microbiome.

The gut-brain mechanism is a complex and fascinating area of research, with implications for animal welfare, nutrition, and health.

Implications for Animal Welfare and Productivity

Maladaptive behaviors compromise welfare (pain, stress, social harm) and reduce productivity (reduced weight gain, egg production, reproductive performance) and increase costs for treatment and culling. Tail biting and severe feather pecking lead to carcass downgrading and elevated mortality; stereotypies can reduce feed efficiency and complicate handling and marketing. Thus, investments in prevention often have rapid economic payback by reducing losses.

Management Strategies

While we are covering ways to address, reduce, and lower the risk of residents developing abnormal behaviours more in-depth in another resource, we want to leave you with some brief tips on promoting well-being among resident populations. Content, happy, healthy residents are much less likely to develop abnormal behaviours.

When providing diets to residents, offer appropriate foods, meet their nutritional needs, allow and encourage natural eating and drinking behaviour, and space meals throughout the day when possible and appropriate [14].

Living spaces should provide comfortable shelter that allows free movement and the ability to distance oneself from social conflict. Additionally, try and make the environments centred on the particular species (while also considering the individual) and that encourage residents to engage with their environment. Providing manipulable materials (straw, ropes, toys), roughage that requires foraging, perches and litter (poultry), and turnout (horses, ruminants) reduces abnormal behaviours. Meta-analyses and systematic reviews show consistent benefit across species; however, enrichment must be appropriate (species-relevant) and maintained to remain effective.

Develop an enrichment schedule Integrate physical/structural, social, nutritional, sensory, and cognitive enrichment into their daily lives. Environmental enrichment has been shown to improve well-being over and over again.

Whenever possible, allow residents choice. Allowing residents to remove themselves behind a visual barrier, respecting their desire to walk away, or offering different enrichment and "asking" what they prefer can make a tremendous difference in promoting well-being.

Perform regular health check-up. This cannot be overstated. Regular health checks, pain control, parasite management and early treatment of wounds reduce triggers for abnormal behaviour (e.g., pruritus leading to biting). Monitoring systems that record behaviour and welfare indicators (e.g., camera systems, automated behaviour detection) enable early intervention. It is vital that in addition to a daily once over and keeping a general eye out, thorough health checks take place regularly. This will help you catch health issues early.

Because multiple interacting drivers typically cause maladaptive behaviours, integrated farm-level plans combining environment, nutrition, genetics and management yield the best outcomes. Economic analyses often show that preventive measures (e.g., straw provision, enrichment objects) are cost-effective compared to the losses from injuries and carcass damage.

Ensure appropriate social groupings. Shun the habit of isolating social individuals whenever possible. Avoid overcrowding and pay close attention to group dynamics to ensure harmonious relations.

Treat everyone as the individual they are and develop care plans that accommodate their differences and needs. Understanding the foundations of the neurobiology of behaviour and well-being can help us better achieve animal welfare. Behaviour is the expression of several physiological, endocrine, motor and emotional responses that are coordinated by the central nervous system from the processing of internal and external stimuli. In mammals, seven basic emotional systems have been described that when activated by the right stimuli evoke positive or negative innate responses that evolved to facilitate biological fitness. This review describes the process of how those neurobiological

systems can directly influence animal welfare. We also describe examples of the interaction between primary (innate) and secondary (learned) processes that influence behaviour.

Research Gaps and Future Directions

- Mechanistic studies linking early life microbiome, neurodevelopment and later behavioral phenotypes in production species.
- Longitudinal intervention trials that quantify production and welfare trade-offs for combinations of enrichment and nutritional strategies.
- Economics and scaling: cost-benefit analyses for enrichment solutions in low-input systems and smallholder contexts.
- Precision monitoring: development of affordable automated behaviour detection for early warning in commercial farms.
- Breeding strategies: integrating behavioral traits into selection indices without sacrificing productivity.

Conclusion

Maladaptive behaviours in farm animals emerge when environmental, nutritional, and social needs are not met [15-27]. They are indicators of welfare compromise and have significant implications on productivity and economics. Evidence consistently shows that improving nutrition, housing, enrichment, and management greatly reduces abnormal behaviours. Future research should integrate genetics, nutrition, welfare science, and neurobiology to design systems that support natural behaviours and improve animal well-being.

Addressing maladaptive behaviours in farm animals requires a multifaceted approach, integrating environmental management, proper husbandry practices, and genetic considerations. By understanding and mitigating the factors leading to these behaviours, we can enhance animal welfare and improve productivity in farm systems.

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