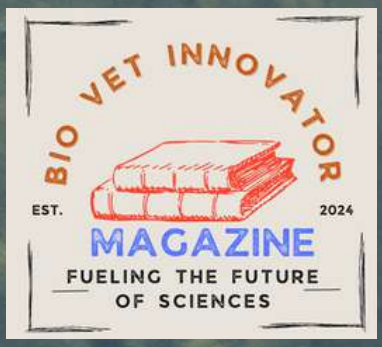
Bio Vet Innovator Magazine

Fueling The Future of Science ...

September | 2024

Volume 1; Issue 3



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Preface

Dear Readers,

It is with immense pride and enthusiasm that I present to you the second issue of Bio Vet Innovator. Following the successful launch of our inaugural edition, this issue marks another significant milestone in our ongoing mission to contribute to the ever-evolving fields of veterinary, agriculture, and allied sciences. As the Editor-in-Chief, I've had the privilege of working alongside a passionate and dedicated team, all united by a shared commitment to advancing knowledge and fostering innovation within our scientific community.

The motivation behind Bio Vet Innovator is rooted in a simple yet profound belief: the future of veterinary and agricultural sciences hinges on the continuous exchange of ideas, the relentless pursuit of research excellence, and an unwavering commitment to improving the health and well-being of animals, plants, and the ecosystems upon which we all depend. Our goal is to create a dynamic platform where professionals, scholars, and enthusiasts can share insights, challenge existing paradigms, and inspire new directions in research and practice.

In this second issue, we continue to offer a diverse array of articles that address the pressing challenges and opportunities within our fields. From cutting-edge research to practical case studies, each contribution has been thoughtfully selected to provide you with valuable knowledge and fresh perspectives. Additionally, we've included thought-provoking reviews and opinion pieces designed to stimulate meaningful discussion and encourage further exploration.

The journey to establish a publication like Bio Vet Innovator is no small feat, and it would not have been possible without the steadfast support of our contributors, editorial team, reviewers, sponsors, and the broader scientific community. I extend my deepest gratitude to each of you for your trust and belief in the vision we've set forth.

As we continue this exciting journey together, I invite you to engage with our content, share your thoughts, and become an active participant in our growing community. Bio Vet Innovator is more than just a magazine—it's a collaborative effort to shape the future of veterinary, agriculture, and allied sciences.

Thank you for being part of this journey. I look forward to the innovations and advancements we will explore together in the pages of Bio Vet Innovator.

Dr. Sudesh Kumar Dedar
Co-Founder & Editor in Chief
Bio Vet Innovator
Mob. – 8107570118

Preface

Dear,

I hope this letter finds you in good health and high spirits.

I am excited to introduce you to the second issue of BIO VET INNOVATOR, our open-access online monthly magazine, dedicated to fueling the future of science through innovation, research, and thought leadership in the fields of veterinary, agricultural, fisheries, biotechnology, environmental, and allied sciences. Since our inauguration in July 2024, we have been committed to providing a platform for advancing knowledge and fostering collaboration within our scientific community.

As Managing Editor, I am reaching out to esteemed faculty members like yourself to invite you to participate in our growing scientific community. Together, we aim to cultivate a network of like-minded individuals who are passionate about exploring the intersection of science and practice.

Enclosed with this letter, you will find our magazine's latest flyer, which offers a glimpse into the content and vision of BIO VET INNOVATOR. Additionally, we have included a membership form for your consideration. Becoming a member will not only grant you full access to our magazine's rich content but also allow you to connect with professionals who are at the forefront of scientific innovation.

I would be honored if you could share this opportunity with your colleagues and peers, encouraging them to join us in our mission to advance the frontiers of veterinary and biological sciences. Your support and participation would be invaluable in helping us build a vibrant and dynamic community.

For more information or to join our community, please visit www.biovetinnovator.in or contact us directly at biovetinnovator@gmail.com.

Thank you for your time and consideration. I look forward to welcoming you to the BIO VET INNOVATOR community.
Warm regards,

Dr. Anil Choudhary
Co-Founder & Managing Editor
BIO VET INNOVATOR
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Acknowledgment

The creation of BioVet Innovator has been a journey of collaboration, dedication, and unwavering support from a community deeply committed to advancing veterinary, agriculture, and allied sciences.

First and foremost, we extend our heartfelt gratitude to the contributing authors, whose insightful articles and cutting-edge research form the backbone of this publication. Your expertise and passion are the driving forces behind this magazine.

A special thank you to our editorial team, whose meticulous attention to detail and tireless efforts have shaped each issue into what it is today. Your commitment to excellence ensures that our readers receive the highest quality content. We also extend our sincere appreciation to our reviewers for their valuable input and support.

To our colleagues and mentors, your guidance and encouragement have been invaluable throughout this process. Your belief in the potential of this magazine inspires us to strive for excellence continuously.

Finally, we wish to thank our family and friends for their constant support and understanding as we dedicated countless hours to this project. Your love and patience have been our strength.

This magazine is not just a publication; it is a testament to the collective effort of a community passionate about innovation and the future of science. We look forward to continuing this journey together as we explore and shape the future of our field.

Dr. Anil Choudhary
Co-Founder & Managing Editor
Bio Vet Innovator Magazine

Dr. Sudesh Kumar Dedar
Co-Founder & Editor-in-Chief
Bio Vet Innovator Magazine

BIO VET INNOVATOR
EST. 2024
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About Us

Bio Vet Innovator Magazine, an open-access, peer-reviewed publication, launched on July 4th, 2024. It serves as a platform for researchers, students, scholars, and scientists to exchange ideas on cutting-edge topics in veterinary, agricultural, and allied sciences (Biotechnology, Microbiology, and Environmental).

The magazine's goal is to disseminate information on the latest innovations and emerging experimental technologies globally. By doing so, it facilitates the sharing of scientific discoveries and advancements within the global scientific community focused on veterinary, agriculture, and allied sciences.

Bio Vet Innovator Magazine will be published monthly as an online open-access magazine on our official website www.biovetinnovator.in

We welcome submissions of new information, novel technologies, and original articles from the fields of veterinary, agriculture, and allied sciences (Biotechnology, Microbiology, Environmental). To ensure credibility, all articles will undergo review by subject matter specialist editors, principal scientists, research scholars from various institutions, and senior professors from different universities in India. Accepted articles may cover a range of disciplines including Veterinary Science, Animal Science, Agriculture, Horticulture, Dairy Science, Fisheries, Forestry, Biotechnology, Life Sciences, and Environmental Sciences. Authors are requested to adhere to the author guidelines policy when submitting short communications and technical/popular articles.

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AIM

The goal of Bio Vet Innovator Magazine is to feature the most recent innovations and emerging experimental technologies poised for global adoption in veterinary, agriculture, and allied sciences.

This initiative aims to distribute scientific insights and the latest research findings throughout the global scientific community engaged in allied sciences worldwide.

MISSION

- Our mission is to strengthen the Animal husbandry practices and transfer the technologies from Lab to Farm.
- To transform innovations in Animal Science Sector into successful businesses for economic growth and employment.
- To act as a catalyst for nurturing entrepreneurial and start-up ecosystem for sustainable growth of livestock & allied sector.
- To love and care for each and every animal just like we would want someone to take care of.
- To connect the farmers with experts in research, technological advancement in Livestock and allied sector.
- To act as a platform for the dissemination of knowledge for the betterment of Livestock and allied sectors.
- To contribute for the development of Livestock and allied sector by introducing them to various schemes and polices through Bio Vet Innovator Magazine network.

VISION

The mission of Bio Vet Innovator Magazine is to provide an independent, authentic, high quality and peer reviewed platform to publish articles related to Veterinary Sciences, Animal Husbandry Practices, Livestock Sector and concerned allied sciences about latest innovations globally.

The word “Bio Vet Innovator” signifies the prominence given to the Animal Husbandry field and other allied sciences in today’s era.

Our magazine offers platform and broad coverage for Veterinary Science, Animal Husbandry, Agricultural Science and Allied sciences researchers and scientists for deliberating connecting throughout India and globally.

For all of these endowed with inquisitive mind and driven by professional goals, this magazine will be a voyage of discovery.

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"Science is a beautiful gift to humanity; we should not distort it."

Dr. APJ Abdul Kalam
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BIO VET INNOVATOR MAGAZINE (Fueling The Future of Science)

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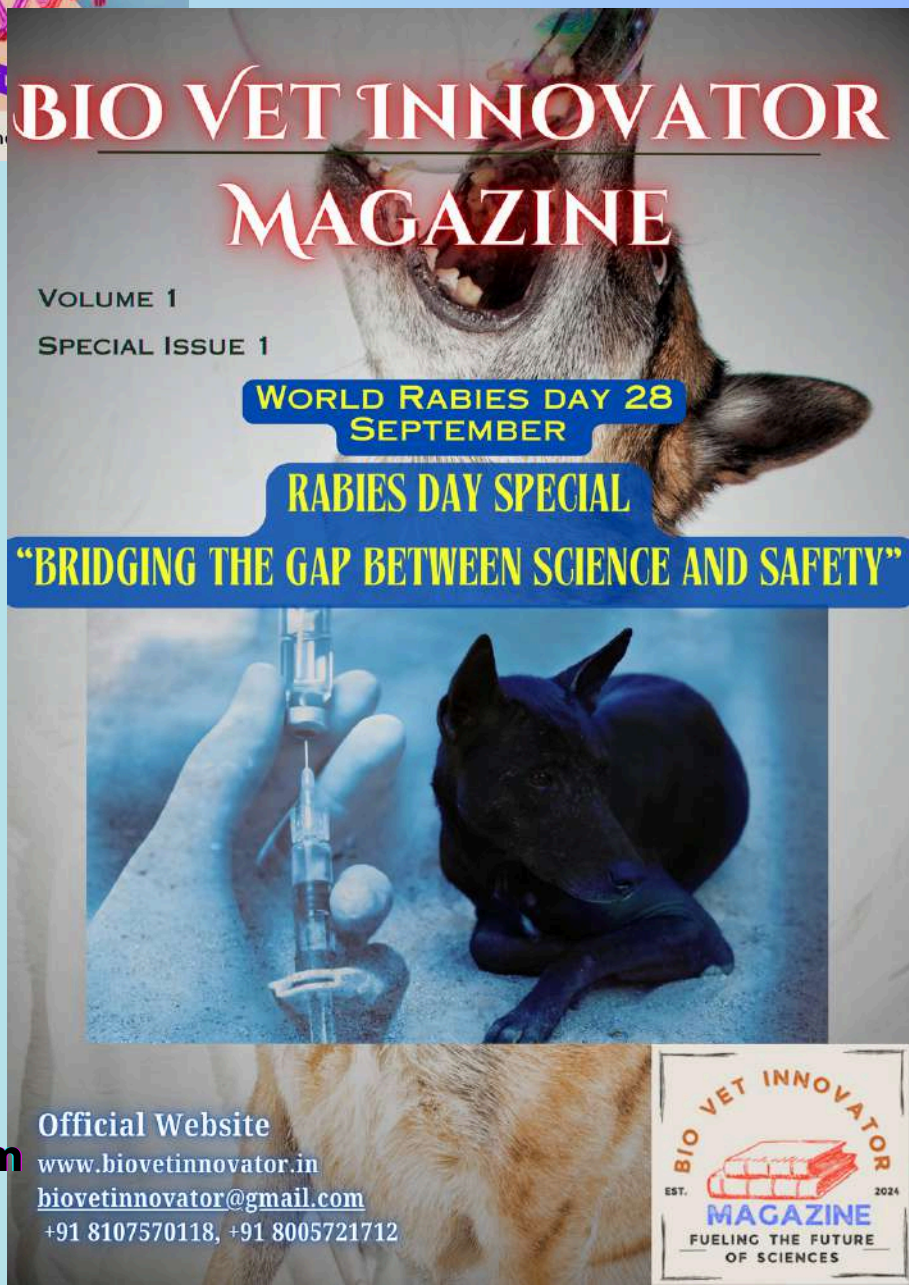

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BIO VET INNOVATOR Magazine

July | 2024

Volume 1; Issue 1

'Fueling the Future of Sciences'

Dr. Sudesh Kumar Dedar
Dr. Anil Choudhary
Co- founder

Bio Vet Innovator Magazine

August | 2024

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Volume 1; Issue 2

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Our Recently Published Book

Exploring Veterinary Science: Insights and Innovations Volume 1.0

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Upcoming Book: Call for Book Chapters

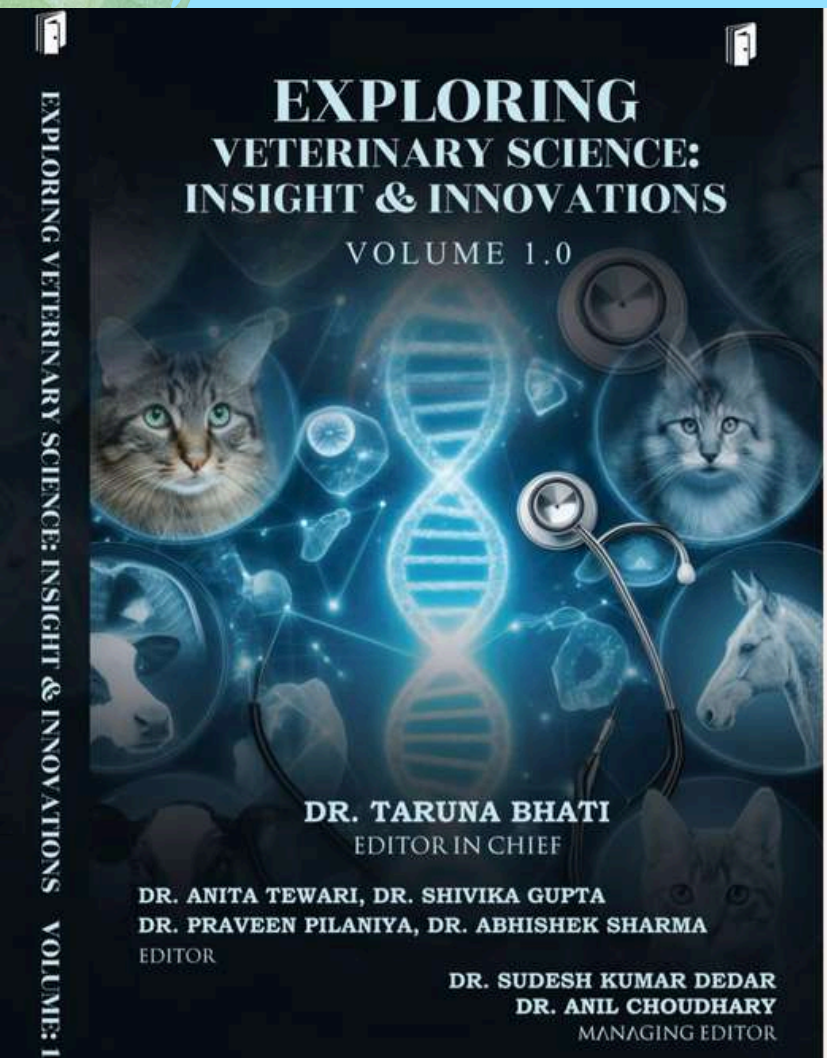
"Innovative Poultry Science: Trends, Disease Management, and Future Perspectives"

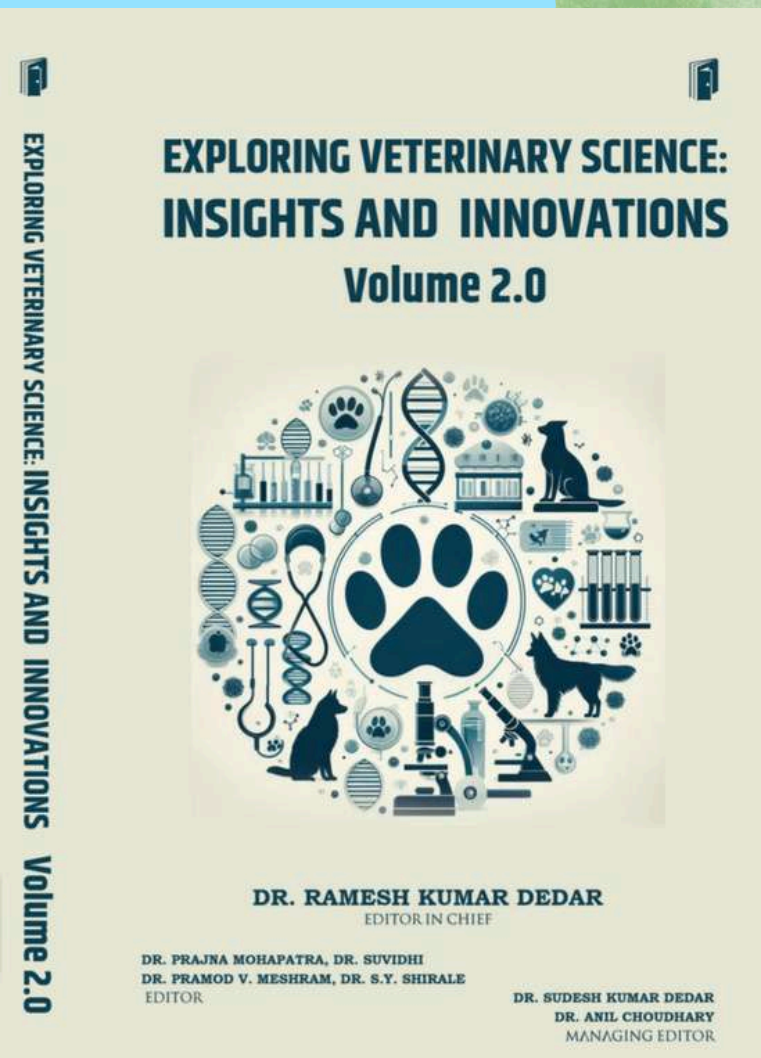
Brief Info:

We are pleased to invite contributions for an upcoming book titled "Innovative Poultry Science: Trends, Disease Management, and Future Perspectives." This book aims to provide a comprehensive overview of the latest advancements, trends, and future directions in poultry science, with a particular focus on disease management, nutrition, and sustainability. The book is intended for researchers, academics, industry professionals, and students, offering in-depth insights into the evolving landscape of poultry science.

Submission Deadline:

30th September, 2024





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DR. RACHANA SHARMA AND DR. TANMAY MONDAL

Department of Veterinary Physiology and Biochemistry, College of Veterinary Science, Rampura Phul, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab

is awarded with Best Article Award for the article titled

‘Poultry Waste Management in India: A Growing Challenge’

published in the *September 2024 Vol 1 Issue 3* of

Bio Vet Innovator Magazine.

Dr. Anil Choudhary
Co-Founder,& Managing Editor

2024

Dr. Sudesh Kumar Dedar
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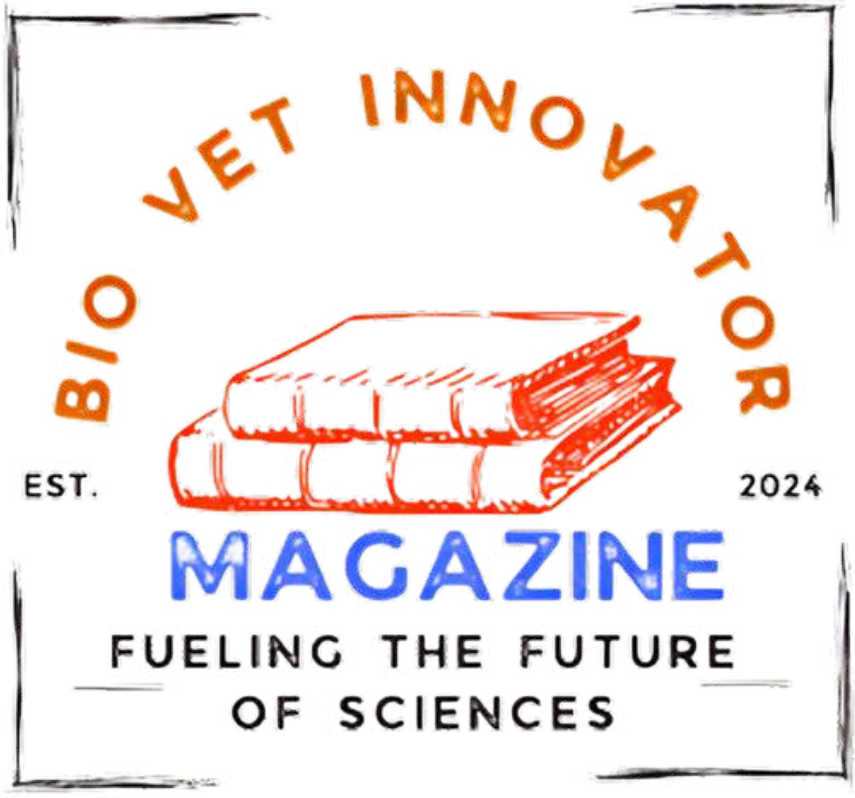

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BIO VET INNOVATOR MAGAZINE
EST. 2024
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CONTENT

Bio Vet Innovator Magazine

Volume 1 (Issue 3) SEPTEMBER 2024

OPEN ACCESS

Popular Article

Pigeons As A Carrier of Zoonotic Diseases To Humans

Dr. Syedah Asma Andrabi[1*], Dawoud Aamir Nehru[2]

Teaching Associate, Dept. of Veterinary Pathology, COVS Rampura Phul, Guru Angad Dev Veterinary And Animal Sciences University (GADVASU), Ludhiana (Punjab)

*Corresponding Author: syedahasmaandrabi@gmail.com

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Introduction:

Pigeons scientifically named as *Columba livia* are a member of order *Columbiformes* and family *Columbidae*. Their association with humans dates back to prehistoric times. Since time immemorial pigeons were used as a source of communication even in world wars dur to their unmatchable homing instincts. These avian species have been either kept in captivity or domesticated and properly trained for sport purposes and reared for meat purposes as well (Santos et al., 2020). Pigeon racing is popular sport, which has started developing into multimillion-dollar industry. Because of their closeness to the humans and their ability for indoor nesting, they can lead to spread of various zoonotic diseases (Perez-Sancho et al., 2020).

Diseases Transmitted By Pigeons In Humans:

Pigeons can transmit various infections to humans either via inhalation or consumption of improperly cooked meat. Some of the important pathogens include Cryptococcus species, *Coxiella burnetii*; Toxoplasma species, Campylobacter species, Histoplasma, Chlamydia and Escherichia coli O157 (Haag-Wackernagel and Bircher 2010). In addition, human infection by pigeon paramyxovirus has also been reported in people with closer proximity to pigeons (Cui *et al.*, 2023).

Histoplasmosis:

It is caused by the fungus *Histoplasma capsulatum*. The fungus thrives well in damp soil especially in pigeon droppings. The spores of fungus enter via respiratory tract and cause flu like symptoms which includes chills, fever, coughing, fatigue and myalgia. The infection is likely to be subsided on its own by taking symptomatic medications, However, in immunocompromised patients infection can become quite deadly (Kauffman *et al.*,1978)

Cryptococcosis:

The cause of cryptococcosis is a yeast called *Cryptococcus neoformans*. The transmission route is similar to

histoplasmosis. Disease is clinically presented in respiratory form or encephalitic form especially in immunocompromised patients. In pulmonary/respiratory form symptoms include coughing, fever, chills and angina (chest tightening). If pulmonary symptoms are neglected and not treated well on time, spores may reach brain and other vital organs via hematogenous route and can lead to secondary complications like numbness in extremities, hydrocephalus and confusion. In severe cases meningitis can occur (Tugume *et al.,* 2023)

Psittacosis:

Psittacosis is commonly known by the name parrot fever. The disease is caused by *Chlamydia psittaci,* which is a gram negative, obligate intracellular bacteria. The rate of spread of infection from pigeons to humans is rapid and usually occurs via infected droppings or handling diseased birds. Symptoms associated with the disease are usually nonspecific and include unproductive cough, myalgia, skin rashes. However, most important presentation of human psittacosis is community-acquired pneumonia (CAP) (Crosse 1990).

Colibacillosis:

The disease occurs due to infection by *Escherichia coli* which is a gram negative rod-shaped bacteria commonly associated with food poisoning. However, infections by pigeons are not uncommon. The likely route of transmission is ingestion and infection is usually of low grade. So, the infection subsides on its own but if not the symptoms include severe abdominal cramps, nausea, diarrhoea.

Salmonellosis:

Salmonellosis (typhoid fever) is commonly transmitted by direct contact with infected birds or through domestic cats that feed on infected birds. The agent responsible for salmonellosis is bacteria *Salmonella spp.* The infection is characterised by gastrointestinal symptoms that include diarrhoea, nausea, vomiting, cramps in the abdomen.

Q-fever:

Q- fever is caused by Rickettsia named as *Coxiella burnetii* which is obligate intracellular, gram negative bacteria with main reservoirs as animal, birds and ticks. Infection in humans usually occurs by direct contact with infected aerosols or droppings of pigeons. Q fever may be manifested as an acute disease in humans characterized by hepatitis, pneumonia or as a chronic disease mainly manifested by endocarditis (Maurin 1999)

Prevention:

- Since pigeon droppings are a main source of infection to humans, it is better to prevent pigeons from visiting roofs.
- This can be achieved by pigeon proofing the houses in order to maintain safety.
- Use of pigeon spikes, optical gels and bird netting should be appreciated.
- Additionally, regular cleaning of roof tops to prevent pigeon nesting and roosting should be done.

Citation: Syedah Asma Andrabi, Dawoud Aamir Nehru. (2024). Pigeons As A Carrier of Zoonotic Diseases To Humans. In Bio vet innovator magazine (Vol. 1, Issue 3, pp. 1–3). Bio vet innovator magazine. https://doi.org/10.5281/zenodo.13629666

- While cleaning, protective clothing, disposable gloves and boots should be worn.
- A respirator is appreciated to prevent infected dust inhalation.

Conclusion:

- Although, zoonotic diseases from pigeons is a cause of public health concern, still the problem is underestimated due to nonspecific symptoms related to the infections.
- Additionally, microbiological assessments related to pigeon diseases are incorporated only if the patient is severely ill.
- The conditions which favour the maximum transmission of infectious diseases from pigeons to humans is frequent contact with pigeons and poor hygiene practices.
- Moreover, raising public awareness about the disease reporting in pigeons as well as humans to their local veterinary/medical practitioners can significantly help in reducing the further transmission.

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Popular Article

Pathological and Diagnostic Aspects of Squamous Cell Carcinoma in Bovines

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Introduction:

Livestock in India plays a crucial role in the development of rural economy by supplementing family income and with generation of employment in the rural sector, particularly among the landless labourers, small and marginal farmers, and women. Bovines are the key constituent species of livestock. They are raised as livestock for dairy products (milk), meat purpose and as draught animals (pulling carts, ploughing etc.). Bovines in India mainly consist of cattle and buffaloes. According to the 20th Livestock census (2019), the total Livestock population shown a significant increase of 4.6% over Livestock Census 2012 with a total of 535.78 million in India.

Tumours are responsible for the loss of production in bovines resulting in substantial financial losses. Bovine tumours may cause economic losses due to negative impact on productivity, animal health and thus may reduce profits to individual farmers and dairy industry. Tumours, also referred as neoplasms (Greek word) Neo means new, plasma means formation, Neoplasms are broadly classified as benign and malignant. Benign neoplasms are mainly localized, single, showing slow and limited growth and do not show recurrence whereas malignant neoplasms are single/ multiple showing rapid and unlimited growth and recurrence after removal. Malignant tumours metastasize which means they can spread from primary site to distant secondary site within the host body. Malignant tumours grow by expansion, and invade or infiltrate adjacent tissues by growing between cells along the tissue spaces (Udharwar *et al*., 2008).

The term tumour meaning swelling is currently restricted to neoplasm. Malignant tumours are indicated with the term cancer. Tumours are sub classified on the basis of origin. Tumours of epithelial origin involving stratified squamous epithelium are: papilloma (benign) and squamous cell carcinoma (malignant).

- Papillomas of cutaneous or mucosal epithelia in cattle they grow exophytically (outward projections). The papillomas are benign tumours which generally regress, but occasionally persist and transforms into malignant squamous cell carcinoma. Papillomas are commonly occurring tumours of epithelial origin in domestic animals.
- A malignant tumour of the stratified squamous epithelium of either the skin, or a mucous membrane, is called a squamous cell carcinoma (SCC) and it occurs mostly in older animals (Vegad, 2007). Squamous cell carcinoma (SCC) is one of the most common malignant neoplasm which is capable of metastatic spread and is observed in various forms across many animals (Yan *et al*., 2011 and Tsujita *et al*., 2010).

Squamous cell carcinoma of horn and eye are most commonly observed cancers in bovines and this article is focused on horn core carcinoma and ocular squamous cell carcinoma.

Squamous Cell Carcinoma of Horn:

Squamous cell carcinoma of horn, also known as horn cancer, is a prevailing type of cancer in cattle especially *Bos indicus* (Bhatia *et al*., 2020).

Horn cancer is generally unilateral (occurs at base of one horn either left or right side) and is encountered in cattle between 5-10 years of age (Tyagi and Singh, 2006).

In India, horn cancer affects approximately 1% of the cattle population and constitutes about 83.34% of total tumours reported (Singh *et al*. 2005).

It is one of the most commonly encountered neoplastic conditions of economic importance in zebu bullock (Somvanshi, 1991 and Kumar and Thilagar, 2000).

Exact etiology of the condition is not known, predisposing factors like irritation due to tying of a rope to the horn, trauma (rubbing, sudden fall against hard object, fighting etc.) and chronic irritation caused by yoke (Shastry, 2001), painting of horn, solar radiations, exposure to actinic rays or viruses etc. are observed.

Ocular Form of Squamous Cell Carcinoma:

Another important form of SCC is ocular squamous cell carcinoma (OSCC). OSCC is one of the most common neoplasms of the eye. The incidence of eye cancer in cattle was observed to be high in animals above 5 years followed by 2-5 years of age (Heeney and Valli 1985). Squamous cell carcinoma is by far the most common tumour afflicting the bovine eye, as well as the most frequently diagnosed cancerous tumour in bovines. Hereditary factors, environmental factors, lack of eyelid pigmentation, age and dietary habits have all been recognized to play a role in the aetiopathogenesis of bovine ocular squamous cell carcinoma. It is a primary neoplasm of epithelial origin and occurs at the site of ocular and periocular tissues including the palpebral skin, epithelial surfaces of the cornea and conjunctiva, third eyelid and limbus (Fornazari *et al*., 2017). Early recognition is critical due to the malignant tendencies of this tumour. In addition, in bovines the aetiology has been linked to a number of viral agents, especially bovine papillomavirus (BPV) (Ford *et al.*, 1982; Rutten *et al.*, 1992) and bovine herpes virus type 1 (BHV-1) (Taylor and Hanks, 1969) and 5 (BHV-5) (Anson *et al*., 1982).

Significance:

- Squamous cell carcinoma of horn is one of the most common cancer which is capable of spreading metastatically and is observed in various forms across many animals and humans.
- Horn cancer is a sporadic, malignant neoplasm affecting the horn core epithelium and predominantly seen in aged zebu bullocks and rarely observed in buffaloes.
- Horn cancer is one of the serious conditions in bullocks. The bullocks are highly susceptible as compared to bulls and cows.
- The malignant tendencies of this neoplasm make early recognition critical.

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Clinical Signs:

- Frequent head shaking, tilting at the affected side, bending of affected horn and increased nasal discharge on the affected side in advance cases
- Grossly, cancerous growth observed with spongy texture, pink cauliflower like tumour having rough and verrucous (wart like) surface which is friable and bleed easily (Reddy *et al*., 2017).
- Cauliflower like ulcerated growth with bleeding at the base of the horn invading deep into underlying tissue (Sharma *et al*., 2020).
- Sometimes gradual bending of horn with fowl smelling, purulent discharge due to secondary bacterial infection in cancerous growth is also observed.
- Later on infection of the tumourous growth by bacteria occurs and the suffering animal may spread and transmit infection via contact or rubbing of affected horn with other animal.

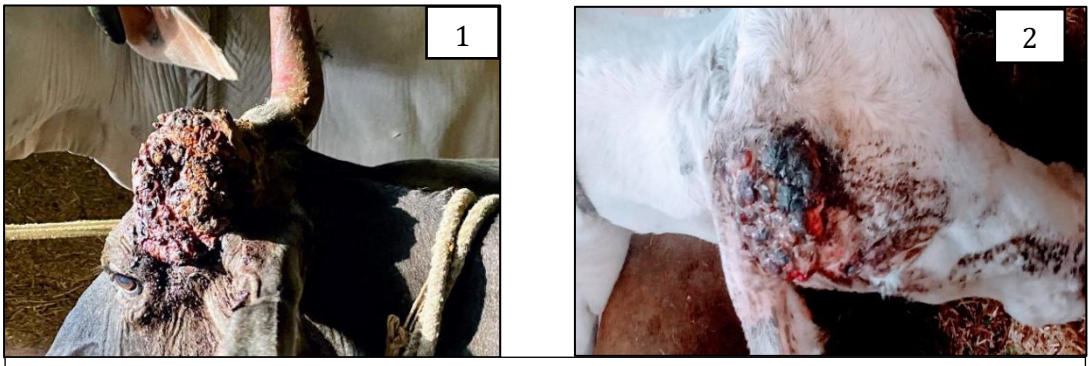

Fig.-1&2: Tumourous growth resembling a cauliflower at the base of Left Horn (Fig.1) and Right Horn (Fig. 2)

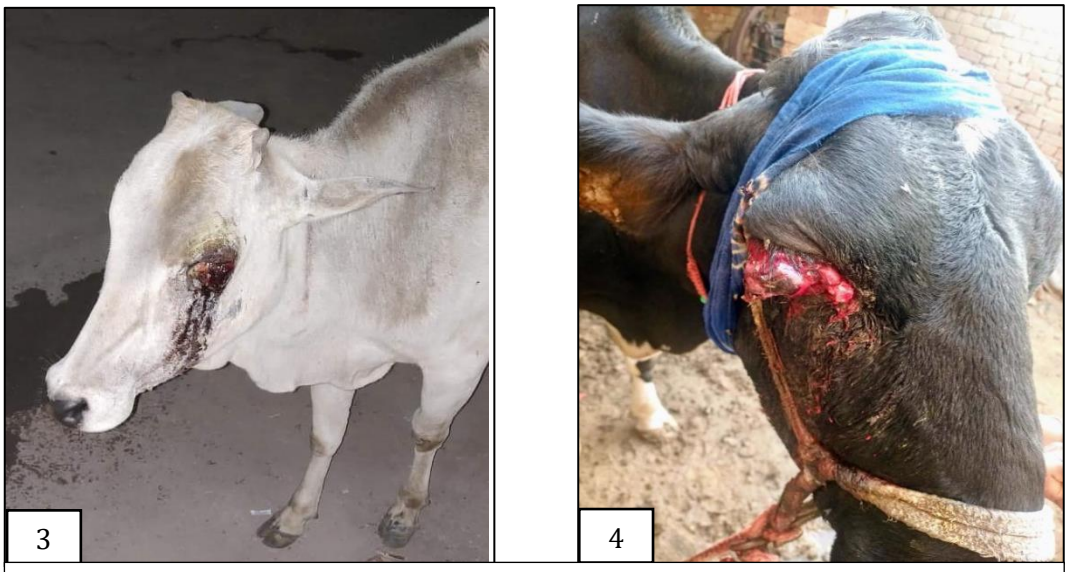

Fig.-3&4: Neoplastic growth at nictitating membrane of Left Eye (Fig.3) and Right Eye (Fig. 4).

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Susceptibility:

- Horn cancer is a type of SCC with poorly-defined genetic landscape, which arise from pseudo stratified columnar epithelium of the horn core mucosa, reported only in indegenous cattle (*Bos indicus).*
- Breed variations have also been seen with higher frequency of squamous cell carcinoma of horn in Kankrej breed than other zebu cattle, non-descript or cross-bred cattle, purebreds have been observed more susceptible as compared to cross-bred cattle (Carvalho *et al.,* 2005 and Gharagozlou *et al*., 2007).
- The breed wise incidence of eye cancer in cattle revealed highest incidence in Hereford (exotic breed of cattle and HF crossbred followed by jersey crossbred cows and non-descript breeds. Ocular squamous cell carcinoma was also reported in Indian buffaloes but is very rarely observed.

Diagnosis:

1. Histopathological Examination:

Histopathological examination is most commonly used in diagnosis of horn cancer. Histopathologically, horn cancer is either well differentiated with presence of cell nests (keratin pearls) or poorly differentiated with absence of keratin pearls (Joshi et al., 2009). Typical concentric layers of keratin forming "epithelial pearls" were observed under microscope. Some histopathological studies are suggestive of anaplastic changes shown by tumour cells such as hyperchromatic nuclei (darkly stained nuclei) and mitotic figures (dividing cells mainly found in abnormal tissues such as cancers).

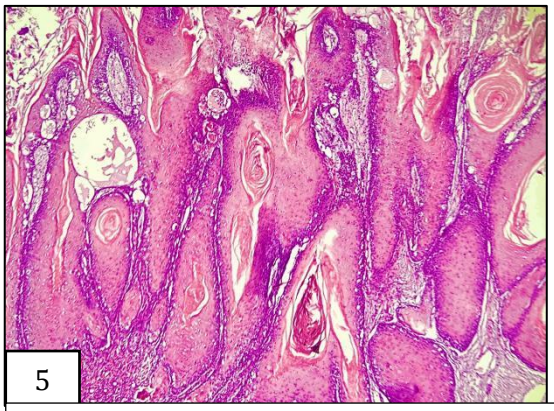
Anaplasia is one of the characteristic features of malignant neoplasms, also observed in horn cancer. Anaplasia means reversion of cells to a more primitive or undifferentiated or towards embryonic form. It indicates de-differentiation, or loss of the structural and functional differentiation of normal cells (Carvalho et al., 2005). Hemorrhages and inflammatory cells such as lymphocytes, plasma cells and neutrophils are seen in local stromal and deep dermal connective tissue.

Well differentiated tumours are characterised by whorls (pearls) with intensely eosinophilic keratinized centers (Pugliese et al., 2014). The neoplastic epithelial cells are arranged in islands of squamous neoplastic cells; some of these islands contained keratin pearls (Kumar et al., 2023). Nuclear and cellular pleomorphism is shown by neoplastic cells, elevated mitotic index with numerous atypical mitotic figures; severe necrosis, hemorrhages are commonly observed under the microscope.

2. Cytological Examination:

- For tumour diagnosis a non-traumatizing technique, carried out by sampling in order to examine tumour cells, scraping of accessible mucosae and skin or other easily accessible tissues provide the cytologist with the samples necessary for a microscopic examination in order to establish the tumour nature.

- Condensation of nuclear chromatin, prominent nucleoli, severely dyskaryotic cells with irregular hyperchromatic nuclei, anisonucleosis (variation in size of cell nuclei, most pronounced in dysplasia and malignancy), bizarre mitoses, multinucleation and increased nucleocytoplasmic ratios, are mainly observed in smears prepared from histologically confirmed squamous cell carcinoma (Hoffmann *et al*., 1978).
- Cytological examinations are countered by the difficulty of interpretation; negative diagnosis frequently occurs in the case of neoplasms that will subsequently be diagnosed histologically.



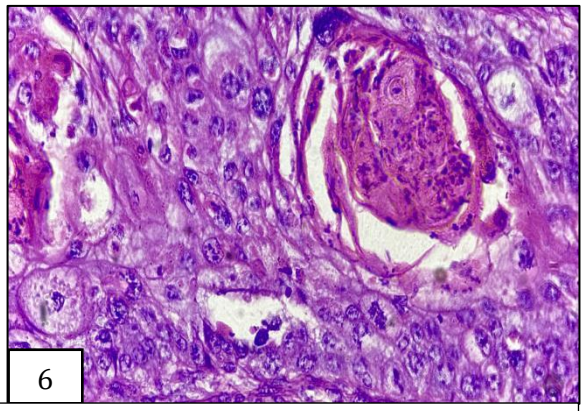


Fig.-5&6: Microscopic examination revealing squamous cell carcinoma with well differentiated epithelial pearls.

(Fig. 5 H&E X 100; Fig. 6 H&E X 400).

3. Immunohistochemistry:

Confirmatory diagnosis of SCC in bovines is done on the basis of detection of biomarkers or tumour markers by immunohistochemistry and immunohistochemical findings. Immunohistochemical evaluation of cases suspected of squamous cell carcinoma in bovines serve as a vital diagnostic technique. Immunohistochemistry as per National Cancer Institute (NCI) is defined as a laboratory method in which antibodies are used to check for certain antigens (markers) in a tissue sample. Antibodies linked to an enzyme or fluorescent dye bind to antigen in the tissue sample resulting into activation of enzyme/ dye and antigen can be visualized under microscope.

Significant Biomarkers Used for The Detection of SCC By Immunohistochemistry:

- Tumour markers are the unique attributes that may reflect the neoplastic process by their high / low level of expression as compared to that of normal cells, offering a putative use in the diagnosis, prognosis and tumourogenesis of cancer (Sharma *et al*., 2020).
- Various biomarkers aids in the diagnosis of squamous cell carcinoma (both horn and eye) in the studies conducted in the past, such as: **p53, keratins, cytokeratins (pancytokeratin), p16, EGFR (Epidermal Growth Factor Receptor), VEGF (Vascular Endothelial Growth Factor), interleukins** etc.
- Immunohistochemical studies involves immunoexpression of these biomarkers in stained tissue

samples examined under microscope.

1. Tumour suppressor genes:

- p53 gene makes protein that is found inside cell's nucleus and plays a key role in controlling cell division and cell death. Mutations in the p53 gene may cause cancer cells to grow and spread in the body, these mutations have been found in many types of cancer (Sharma *et al*., 2020).
- Squamous cell carcinomas commonly have mutations in p53, and positive immunolabeling for p53 has been reported in animals especially in SCCs of non-pigmented skin secondary to exposure to UV radiation (Kumar *et al*., 2023).
- The tumour suppressor gene p16 has gained widespread importance in cancer, frequent mutations and deletions of p16 in human cancer cell lines first suggested an important role for p16 in carcinogenesis (Fornazari *et al*., 2017 and Liggett *et al*., 1998).
- SCCs have been shown to express p16 through immunolabeling. Antibodies targeting p53 and p16 have been used as prognostic factors in SCCs (Fornazari *et al*., 2017).

2. Cytokeratin:

- Cytokeratin is one of the most important tumour markers for diagnosis of epithelial tumours such as horn cancer, high variations in expression patterns of cytokeratin have been correlated to different pathways of epithelial differentiation leading to the accurate diagnosis and classification of tumours of epithelial origin into different subtypes by immunohistochemistry (Sharma *et al*., 2020).
- Pan- Cytokeratin expression under microscope shown by tumour cells with a distinct reddish brown cytoplasmic staining were considered positive.
- Cytokeratin expression similar to that in normal epidermal keratinocytes is conserved in well-differentiated horn cancer, but the change in expression of cytokeratins is observed during progression to malignant transformation.
- The expression of simple epithelial or non-cornifying stratified squamous epithelial cytokeratins in cutaneous tumours mainly in horn cancer is a marker for their capability of invasion and metastatic potential (Panchal *et al*., 2020).
- Earlier studies on SCC revealed keratins and interleukins (cytokines expressed and secreted by leucocytes and other body cells, plays essential role in differentiation of immune cells in pro-inflammatory and inflammatory processes).
- Upregulation of keratin supports metastasis of tumour via cell proliferation, migration and effecting cell stability, while downregulation of interleukins deprives the immune response to tumour posing a clear pathway for metastasis of horn cancer.

3. EGFR:

Epidermal Growth Factor Receptor (EGFR) is a key factor in malignant tumours of epithelial origin, and its activity enhances tumour growth, invasion and metastasis by induction of angiogenesis (formation of new

blood vessels, commonly seen in malignant neoplasms which is responsible for their rapid growth) (Lakshmi *et al*., 2020).

4. VEGF:

Vascular Endothelial Growth Factor (VEGF) is a potent angiogenic factor, produced by variety of cells such as: keratinocytes, epithelial cells, macrophages, mast cells, fibroblasts etc. It is involved in several types of tumours, shown influence in both tumour neovascularization and dissemination (Lakshmi *et al*., 2020). Scientific studies suggested a possible role of VEGF in development of eye cancer in bovines through angiogenesis, with immunoexpression of VEGF in bovine OSCC.

Conclusions:

- Cytological examination of tumours suspected of SCC by is characterised by variation in anisocytosis and poikilocytosis with altered nuclear details.
- SCC of horn is generally unilateral and characterised by large cauliflower like ulcerated growth with bleeding at the base of the horn with rough and verrucous surface.
- Ocular neoplastic growths vary from soft to hard in consistency. Firm cauliflower like mass, extending deep into the frontal and nasal sinus, congested with verrucous surface is also seen in OSCC.
- Cell nests or keratin pearls with high degree of keratinization and layered pattern of keratinization are characteristic of squamous cell carcinoma.
- Immunohistochemistry of tissues using tumour markers like Pan-CK, p53, EGFR, p16 and VEGF aids in confirmatory diagnosis of neoplasms of epithelial origin.
- Pan-Cytokeratin immunoreactivity confirms the tumour of epithelial origin and EGFR immunoexpression is confirmatory for malignancy and degree of metastasis.
- Tumour suppressor genes like p53, p16 plays a crucial role in control of cell division and cell death. Mutations in these genes may cause cancer cells to grow and spread in the body, these mutations are responsible for malignant transformation of cells.

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Popular Article

Methods of Testing Reproductive Toxicity in Female Rats

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Introduction:

Reproductive toxicity refers to the harmful effects that chemicals or physical agents can have on the reproductive systems of both males and females, as well as on developing offspring. Female rats are frequently used as a model in these studies because their physiology closely mirrors that of humans. Additionally, their genetic consistency, short reproductive cycles, and cost-effectiveness make them an ideal choice for research. By using this model, scientists can explore how different substances may affect fertility and fetal development. These studies play a crucial role in assessing the risks posed by pharmaceuticals, environmental toxins, and other substances that could potentially impact reproductive health.

Critical Stages of Reproductive Toxicity Testing:

Reproductive toxicity testing in rats is divided into six key stages that help scientists assess how chemicals affect development and reproduction. The first stage, Stage A, spans from pre-mating to conception, focusing on fertility and early embryonic development. Stage B covers the period from conception to implantation, looking at how chemicals influence early embryo survival. Stage C, known as organogenesis, examines development from implantation until the closure of the hard palate, a critical phase for organ formation. Stage D continues from this point until birth, with a focus on identifying any teratogenic (birth defect-causing) effects. Stage E addresses the postnatal period, monitoring development from birth until weaning. Finally, Stage F evaluates the impact of substances on growth and reproductive ability from weaning to sexual maturity. These stages are essential for understanding how toxins or chemicals can affect reproduction and development at every phase of life.

Reproductive toxicity testing focuses on understanding how substances impact sexual function, fertility, and overall reproductive health. A key part of this research includes fertility and reproductive performance studies, conducted during the early stages of reproduction, which assess fertility, gamete production, and early pregnancy. Multigenerational studies go a step further, evaluating how these effects carry over to future generations.

For non-therapeutic substances, such as industrial chemicals, reproductive and developmental toxicity is often examined as part of long-term repeated-dose toxicity studies. These assessments measure key reproductive

endpoints like fertility rates, estrus cycle patterns, and the health and development of offspring. The evaluation of the estrus cycle is particularly important in female rats. Their cycle, which averages four days, is divided into four stages: estrus, metestrus, diestrus, and proestrus. To ensure they are ready for reproduction, female rats are monitored for 14 days before treatment and then paired with males for breeding. This allows researchers to track any changes in reproductive readiness.

Evaluation of Estrus Cycle:

The estrus cycle in female rats, averages 4 days, consists of four stages: estrus, metestrus, diestrus, and proestrus. Rats are evaluated 14 days before treatment and then cohabited with males to ensure reproductive readiness.

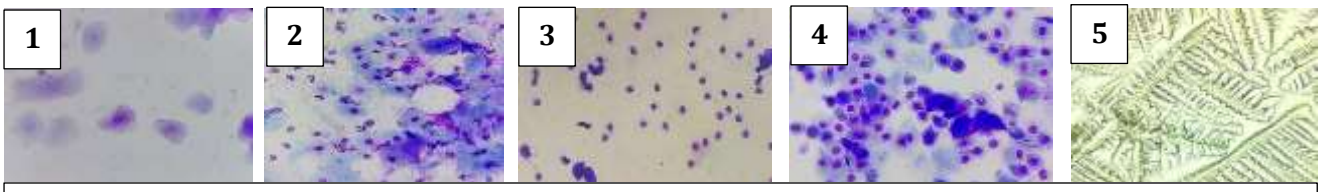

Fig.1 (Estrus) Shows cornified cells. **Fig.2** (Metestrus) is marked by a mix of keratinized epithelial cells and neutrophils. **Fig.3** (Diestrus) has fewer epithelial cells and an increase in leukocytes. **Fig.4** (Proestrus) is characterized by small, round, nucleated epithelial cells. **Fig.5** Typical fern pattern shown by estrus vaginal mucous.

Evaluation of Mating Behaviour:

In reproductive studies, males and females are paired for mating at a ratio of either 1:1 or 1:2. Successful mating is confirmed by the presence of sperm in vaginal smears or by spotting a copulatory plug, which also marks day zero of pregnancy. Female reproductive performance is assessed by measuring how long it takes for mating to occur during cohabitation, the number of females that successfully mate within each group, and the overall pregnancy rates. These indicators help researchers evaluate the impact of substances on reproductive success.

Evaluation of Uterus:

Parameters considered for evaluation of uterus:

- **Uterine Weight**: In non-pregnant females, uterine weight is a marker for evaluating estrogenic activity. It fluctuates during the estrus cycle, peaking at proestrus. Steroidogenesis inhibitors reduce uterine size, leading to weight loss, indicating estrogenic potency and toxicity.
- **Uterine contents**: The uterine horns are opened to examine the contents. The implantation sites are categorized based on their status, which may include early or late resorption, as well as live or dead foetuses. Additionally, the placenta is inspected for any abnormalities and weighed.

Evaluation of Ovary:

The ovary is essential for reproductive functions, including hormone production. Delayed ovulation may impair oocyte viability, raising the risk of trisomy and polyploidy. Disruptions in follicular development, ovulation, or corpus luteum function can negatively impact fertility. Ovarian weight is measured using standard techniques, accounting for dehydration effects and estrus cycle fluctuations. Histopathological evaluation focuses on follicular, luteal, and interstitial compartments, with quantitative analysis of primordial follicles and established sampling methodologies. The count of corpora lutea, indicative of ovulated oocytes, is crucial for implantation and pregnancy maintenance.

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Conclusion:

The Reproductive toxicity testing entails a thorough assessment of six critical stages in rats to evaluate the effects of chemicals on fertility and reproductive health. Important evaluations comprise the examination of estrus cycles, mating behavior, and the health of reproductive organs. Studies on fertility and reproductive performance, along with multigenerational assessments, are vital for identifying the potential risks associated with chemical exposure.

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Popular Article

Single-Cell Gel Electrophoresis: The Role of the Alkaline Comet Assay in Genotoxicity

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Introduction:

The alkaline comet assay or single-cell gel electrophoresis is a sensitive and effective method for detecting DNA strand breaks in individual cells. Widely used in genotoxicity testing, this assay helps researchers assess the impact of chemicals, drugs, and environmental pollutants on genetic material. DNA damage is often associated with mutations and diseases like cancer, making the alkaline comet assay a valuable tool for both scientific research and regulatory safety evaluations.

In Vivo Alkaline Comet Assay in Rats: A Complete Procedural Overview

1. Sample Collection and Cell Preparation:

- **Tissue or Cell Sample**: The assay typically uses cells from animals such as rodents, with samples taken from multiple tissues (e.g., liver, bone marrow, or peripheral blood). Cells can also be derived from cultured cell lines.
- **Cell Suspension**: A single-cell suspension is prepared by isolating the cells from the tissues and suspending them in a buffered medium. Care must be taken to ensure the cells are viable and undamaged before the assay.

2. Slide Preparation:

- **Embedding Cells in Agarose**: The prepared cells are mixed with low-melting-point agarose and spread onto pre-cleaned, labelled microscope slides. The agarose immobilizes the cells, allowing the assay to be conducted without disturbing the DNA within the cells.
- **Solidification**: The slides are then allowed to solidify at room temperature or refrigerated to ensure the agarose gel sets firmly.

3. Lysis:

- **Cell Membrane Breakdown**: The slides are immersed in a cold lysing solution, typically containing detergents and high concentrations of salts (e.g., sodium chloride) at low temperatures (2–8°C) for at least one hour. This step breaks down cell membranes, proteins, and other components, leaving behind the intact

DNA.

- **Rinsing**: After lysis, the slides are rinsed with distilled water or buffer solution to remove the residual lysing solution before the next step.

4. Unwinding and Electrophoresis:

- **Alkaline Treatment**: The slides are placed in an alkaline electrophoresis buffer (pH >13) for about 20 minutes, which causes the DNA to unwind and reveals any strand breaks present in the cell.
- **Electrophoresis**: The slides are then subjected to electrophoresis at a low voltage (usually 0.7 V/cm) for about 20 minutes. The negatively charged DNA fragments migrate toward the positive electrode, forming the comet tail. Intact DNA remains in the cell's nucleus (the "comet head"), while fragmented DNA moves out into the gel, forming the tail.

5. Neutralization:

- **Neutralizing the DNA**: After electrophoresis, the slides are neutralized by soaking them in a neutralizing buffer (e.g., Tris buffer) for about 5 minutes. This step halts the electrophoresis and stabilizes the DNA for analysis.

6. Staining and Visualization:

- **Staining**: The DNA is stained with a DNA-specific fluorescent dye, such as ethidium bromide, propidium iodide, or acridine orange. These stains bind to the DNA and allow it to be visualized under a fluorescent microscope.
- **Microscopic Examination**: The stained slides are viewed under a fluorescent microscope, and the comet-like structures are analysed. The comet head represents the intact DNA, while the comet tail reflects the broken DNA fragments.

Interpretation of the Alkaline Comet Assay Results:

1. Tail Length Analysis:

a. Comet Tail: The primary measure of DNA damage in the comet assay is the length of the comet tail, which increases with the number of strand breaks in the DNA. The tail length represents the distance that the fragmented DNA migrates from the nucleus during electrophoresis.

b. Quantitative Analysis: Various image analysis software can be used to quantify the extent of DNA damage by measuring the length and intensity of the comet tail relative to the comet head. The more significant the DNA damage, the longer and brighter the comet tail.

2. Tail Moment and Tail DNA:

a. Tail Moment: This parameter combines both the length of the tail and the fraction of total DNA in the tail. It is a more comprehensive measure of DNA damage than tail length alone.

b. % Tail DNA: This is the percentage of total DNA that has migrated from the nucleus into the comet tail. A higher percentage indicates more extensive DNA damage.

3. Positive and Negative Results:

a. Positive Result: An increase in the tail length or tail moment compared to the control group indicates the presence of DNA strand breaks, suggesting that the tested substance is genotoxic.

b. Negative Result: If the tail length and tail moment in treated samples are comparable to the control group, the

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test substance is considered non-genotoxic under the conditions of the assay.

4. Positive Controls:

Known DNA-damaging agents, such as hydrogen peroxide or ionizing radiation, are used to validate the sensitivity of the assay.

Conclusion:

The alkaline comet assay is a highly sensitive method for detecting DNA strand breaks, offering valuable insights into the genotoxic potential of chemical substances, drugs, and environmental agents. By revealing both single and double-stranded DNA breaks, the assay provides a detailed look at how exposure to genotoxins can affect the genome. It is especially useful in identifying substances that may lead to mutations, cancer, and other genetic disorders. The assay's ability to assess DNA damage in individual cells from different tissues makes it a versatile tool in toxicology research. The importance of the comet assay extends beyond identifying immediate genotoxic effects; it also plays a critical role in understanding the potential for DNA repair and long-term consequences of genetic damage. Its wide application in pharmaceutical and environmental safety testing helps ensure that harmful agents are identified early, aiding in the development of regulatory guidelines that protect human health and the environment.

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Popular Article

Different Constraints for Livestock Production in The Changing Climate Scenario

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Abstract:

The majority of mammalian biomass on Earth is made up of livestock. More than a billion poor people rely on livestocks for their daily needs. Climate is the average weather over a lengthy period of time, usually thirty years. Climate change needs to be evaluated at the household level in order to focus the ones that are deprived and vulnerable who depends on agriculture. One of the main causes of climate change is anthropogenic activity. Climate change, on the other hand, poses a threat to livestock production due to its effects on biodiversity, animal illnesses, animal reproduction, water availability, feed crop and forage quality, and milk production We can broadly categorize the impacts of climate change into direct and indirect effects.

Keywords: Livestock, climate change, impacts, direct and indirect effects.

Introduction:

Livestocks are essential to modern society because they directly support crop production with manure and draught power, food security and nutrition, and serve as a source of income, jobs, meet social and cultural requirements (Thornton *et al*., 2013). Despite uncertainty surrounding variations in the climate, the IPCC Fifth Assessment Report estimated the "likely range" of a rise in the global average surface temperature by 2100 to be between 0.3°C and 4.8°C (IPCC, 2013). Climate change represents the average and fluctuations of meteorological factors across periods varying from months to millions of years. Changes in the quantity and quality of feed crops and forage water availability animal growth and milk production feed intake heat stress diseases reproduction health and mortality and biodiversity (Reynolds *et al*., 2010) are some of the possible effects on livestock.

Impact of Climate Change on Livestock Production:

Variations in precipitation, increasing temperature and concentration of carbon dioxide (CO_2) in the atmosphere are the main causes of these effects, in accordance with (Collier et al., 2019), the term "direct effects" describes how the environment and CO_2 affect the metabolism, thermoregulation, immunological response, and various productions of livestock. Indirect effects describe the impacts of climate on pest/pathogen populations, feed

productivity, and water availability. In many regions there is an uncertainty that livestock performance will be impacted by climate change, and most prediction models indicate that these effects will be deleterious. In few years, there may be abrupt shifts in climate or more subtly over decades. Climate change is commonly linked to a rise in the Earth's overall temperature. Although animals can adapt to hot climates, the mechanisms they employ for survival may have negative effects on their overall performance.

The Various Impacts of Climate Change Are as Follows:

1. Feed quantity and quality:

These are primarily affected by increasing atmospheric CO_2 levels and temperature (Chapman *et al*., 2012), which cause variations in concentrations of water-soluble carbohydrates and nitrogen. The impact of climate change on forage quantity and quality will vary depending on location, farming system, and species (IFAD, 2010).

2. Water Availability:

Climate change is expected to change water availability and water consumption in livestock production Rising temperatures are expected to increase not only water use for irrigation, but also water use per animal and per land area Another problem is water salination caused by sea level rise). Competition for water between livestock, crops, and non-agricultural use will intensify in the coming decades, requiring more efficient production systems to address water scarcity issues (Reynolds *et al*., 2010).

3. Meat and Milk Production:

Dairy cows that are under heat stress consume less dry matter in their feed, which accounts for about 35% of the drop in milk production in the meantime, the most productive breeds of dairy cows show greater vulnerability to heat stress because they are larger and release more metabolic heat than lower-producing types. As a result, milk production decreases due to increased metabolic heat production due to heat stress Meat production of all major livestock species have been found to be affected by heat stress (Gonzalez-Rivas *et al.,* 2020). Heat-stressed ruminants exhibit reduced body size, carcass weight, fat thickness, and meat quality.

4. Feed Intake:

Inappetence or anorexia is one of the common effects of high environmental temperatures. Ruminants encounter decreased appetite, intestine motility, and rumination as a result of increased ambient temperature. As environmental temperatures rise above 25–26 °C, feed intake of the lactating dairy cow decreases, and this decline happens more quickly above 30 °C. Among ruminants, heat stress has less influence on goats. When the ambient temperature rises above their thermal comfort zone by more than 10 °C, voluntary feed intake of the goats decreases (Yadav *et al*., 2013).

5. Livestock Diseases:

Climate change can have a significant impact on the occurrence, prevalence, and spread of livestock diseases. For example, the distribution and impact of vector-borne diseases such as Rift Valley fever, African horse disease, and bluetongue vary widely due to seasonal and long-term climate change (Baylis and Githeko 2006).

6. Reproductive process:

Reproductive process are affected by heat stress. Pregnancy rates in dairy cows can drop by 20-27% in the summer, with heat-stressed cows experiencing reduced estradiol secretion from dominant follicles that develop in an environment low in luteinizing hormone. Reduced reproductive efficiency due to heat stress leads to

changes in ovarian function and embryonic development by reducing the fertilization potential of eggs and resulting embryos (Naqvi et al., 2012).

7. Biodiversity:

Populations with reduced genetic biodiversity are at risk, and one of the direct drivers of this biodiversity loss is climate change (UNEP, 2012). Alteration in the climate could lead to the extinction of 15-37% of all species around the world (Thomas et al., 2004).

Conclusion:

Increased heat stress as a result of climate change can have a direct impact on livestock production, while indirect effects include changes in the quantity and quality of feeds, changes in the availability of land and water. Associated adaptation techniques might focus on changing the production and management systems or directly target animal responses by modifying the animals' environment and feeding. Climate change needs to be evaluated at the household level in order to focus the ones that are deprived and vulnerable who depends on agriculture. Strategies for livestock adaptation and mitigation could be helpful in reducing the effects of climate change.

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Editorial Article

Exploring Nanotechnology: A New Frontier in Science and Sustainability

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Introduction:

In today's fast-paced world, the demand for portable, durable, lightweight, and sophisticated materials is ever-increasing, driven by the need for sustainability amid a growing population and climate change. This has led to the development of structures composed of particles with specialized characteristics, facilitated by a groundbreaking technology known as nanotechnology. This field has the potential to revolutionize various sectors by modifying the molecular structure of materials to create smart objects with unique properties.

Understanding Nanotechnology:

Nanotechnology involves manipulating matter on an atomic and molecular scale (1-100 nm) to tailor materials for specific applications. Nanomaterials exhibit unusual physical, chemical, and biological properties that differ significantly from conventional bulk materials. For instance, nanoparticles can have increased surface area relative to their volume, leading to enhanced reactivity and strength. Some nanomaterials possess enhanced magnetic properties, improved electrical and thermal conductivity, and superior light reflection. Additionally, nanomaterials can exhibit higher bioavailability when used in agricultural applications, which can improve nutrient uptake in plants and animals.

The term "nano" refers to one billionth of a meter (10^{-9}). Since Richard Feynman introduced the concept in 1959, nanotechnology has progressed rapidly, offering cutting-edge materials to researchers, process engineers, and companies across various scientific fields. This field intersects with disciplines such as physics, chemistry, biology, materials science, and engineering, creating a rich tapestry of potential applications.

Applications of Nanotechnology Across Scientific Fields:

1. **Advanced Fabrics**:
   - **Lightweight Armor**: Nanoscale additives can create lightweight ballistic body armor that not only resists impact but also maintains flexibility.
   - **Functional Textiles**: Fabrics treated with nanosilver nanoparticles resist wrinkling, staining, and bacterial growth, offering both functionality and comfort. These textiles can be used in uniforms, sportswear, and medical clothing.

2. **Smart Surfaces**:
   - **Coating Technologies**: Nanoscale films enhance eyeglasses, screens, and windows with properties such as water and residue repellency, antireflective coatings, and scratch resistance.
   - **Self-Cleaning Surfaces**: Some surfaces are engineered to break down organic material upon exposure to light, leading to self-cleaning properties.
3. **Wearable Technology**:
   - **Health Monitoring**: Washable smart fabrics equipped with nanoscale sensors enable continuous health monitoring by detecting physiological changes such as heart rate and temperature.
   - **Energy Harvesting**: These fabrics can also capture solar energy or harness energy from body movements, converting it into usable power for small devices.
4. **Lightweight Materials**:
   - **Transport Innovations**: Nanotechnology contributes to the development of lightweight materials used in automobiles, boats, and aircraft, significantly reducing fuel consumption and emissions.
   - **Strength and Durability**: The use of nanocomposites enhances strength while maintaining low weight, allowing for safer and more efficient transportation.
5. **Composite Materials**:
   - **Performance Enhancements**: Nanoscale additives in polymer composites enhance the performance of sports equipment (like tennis rackets and bicycles), luggage, and automobile parts, making them lighter and more resilient.
6. **Aerospace Applications**:
   - **Conductive Materials**: Conductive carbon nanotube sheets are ideal for electromagnetic shielding and thermal management in next-generation aircraft and spacecraft, improving safety and performance.
7. **Bioengineering**:
   - **Sustainable Energy Production**: Nanoscale enzymes can convert cellulose from biomass into ethanol for biofuel, providing a renewable energy source while reducing reliance on fossil fuels.
8. **Food and Agriculture**:
   - **Nanotechnology in Packaging**: Cellulosic nanomaterials enhance the barrier properties of packaging, extending the shelf life of perishable items while reducing plastic use.
   - **Precision Agriculture**: Nanofertilizers and nanopesticides can deliver nutrients or pesticides in a targeted manner, improving efficacy while minimizing environmental impact.
9. **Automotive Innovations**:
   - **Energy Storage**: Nanotechnology improves battery systems, including lithium-ion batteries, allowing for faster charging and longer-lasting performance, essential for electric vehicles.
10. **Coatings**:
    - **Enhanced Machine Parts**: Nanostructured ceramic coatings increase the toughness and wear resistance of machine parts, extending their lifespan and reducing maintenance costs.
    - **Extend shelf life**: Nanocoatings in fruits extend shelf life and nano smart packaging for food industry

prevents food spoilage.

11. **Lubricants**:
    - **Efficiency Improvements**: Nanotechnology enhances lubricants to reduce friction and wear, leading to energy savings and prolonged machinery life.
12. **Catalysts**:
    - **Green Chemistry**: Nanoparticles serve as effective catalysts in chemical reactions, enhancing reaction rates and selectivity while reducing the quantity of materials needed, which can lower costs and environmental impact.
13. **Household Products**:
    - **Enhanced Cleaning Solutions**: Nano-engineered materials are found in items like stain removers, air purifiers, and antibacterial cleansers, providing enhanced effectiveness and convenience in daily life.
14. **Personal Care**:
    - **Sunscreen Innovations**: Sunscreens with nano titanium dioxide and zinc oxide provide effective sun protection while remaining invisible on the skin, improving user comfort and efficacy.
15. **Computing and Electronics**:
    - **Next-Generation Devices**: Nanotechnology enables the development of smaller, faster electronic components, enhancing performance in computing, telecommunications, and data storage.
16. **Medical Applications**:
    - **Targeted Drug Delivery**: Gold nanoparticles are used in targeted drug delivery systems that deliver medications directly to cancer cells, minimizing side effects and improving treatment efficacy.
    - **Gene sequencing and vaccine delivery**
17. **Regenerative Medicine**:
    - **Tissue Engineering**: Nanotechnology is being utilized for developing biomaterials that mimic human tissue structure and function, aiding organ transplantation and healing.
18. **Water Purification**:
    - **Efficient Filtration**: Nanotechnology allows for rapid and cost-effective detection and treatment of water impurities, utilizing advanced filtration systems that outperform traditional methods.
19. **Smart Packaging**:
    - **Spoilage Detection**: Smart packaging technologies incorporate nanosensors that can monitor freshness and detect spoilage, reducing food waste and enhancing food safety.
20. **Animal Health**:
    - **Prevents and cure disease:** Nanoparticles in animal feed enhance nutrient absorption and overall health, addressing reproductive and disease issues with the use of sustained release hormones, antibiotics, antioxidants and vitamins.
21. **Animal production**:
    - **Increase animal number**: Nanosensors detects estrus, nanofluidics helps in cryopreservation of gametes and seperates healthy sperm and oocytes and nanocapsules containing bull semen conducts artificial

insemination in cows.

22. **Forestry**:

- **Efficient preservation:** Nanoparticles protect woods from fungi, termites and borers, make resistant to ignition and improves durability.

Challenges and Considerations:

While the benefits of nanotechnology are extensive, there are potential drawbacks and challenges that must be addressed:

- **Health and Safety Risks**: Research indicates that nanoparticles may accumulate in the lungs, brains, and nasal cavities of animals, raising concerns about long-term health effects. More studies are needed to understand how these particles interact with biological systems.
- **Environmental Impact**: The environmental fate of nanoparticles is not fully understood, particularly regarding their interactions with other environmental substances and their longevity in ecosystems. Their potential to enter the food chain raises questions about human exposure and health risks.
- **Regulatory Frameworks**: Current regulations may not adequately address the unique challenges posed by nanomaterials. Establishing clear and effective regulatory frameworks is vital to ensuring the safe development and use of nanomaterials. Policymakers must work alongside researchers to create guidelines that balance innovation with public safety.
- **Public Perception and Acceptance**: Public understanding of nanotechnology is still evolving, and addressing misconceptions is vital for its acceptance. Transparent communication about both the benefits and risks is necessary.

Conclusion:

Nanotechnology has demonstrated its versatility across multiple domains, revolutionizing agriculture, veterinary science, medicine, information technology, transportation, food safety, and environmental science. As the market for nanotechnology continues to grow, it presents lucrative opportunities for investment in nanodevices that could reshape our future. In light of increasing global population pressures and climate change, the integration of nanomaterials in various sectors is critical for achieving sustainability. Researchers must prioritize studying this technology across different scientific fields to ensure a healthier and more sustainable world. Collaborative efforts among scientists, policymakers, and the public will be essential to harness the full potential of nanotechnology while addressing its challenges responsibly.

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Popular Article

Critical Insights into Animal Welfare and Protection Laws in India

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Introduction:

Humans first appeared as hunter-gatherers in prehistoric periods, and they have since developed into established groups centred on agriculture. Because they have either tamed animals or made them their prey, they have been linked to animals. Taking care of animals and making oneself comfortable dates back to the Neolithic era, at least 10,000 years ago, when animal husbandry first emerged. People were required to take animal welfare into account in order to accomplish their personal goals by the integrity and ethics of animal welfare that emerged throughout the Neolithic era. "If we take care of animals, animals will take care of us" (Strand, 2014). During the last part of the 20th century, the field of veterinary medicine dedicated to animal welfare has grown into a distinct specialty unto itself.

Animal welfare refers to both the human-animal bond and the responsibility that those who live in their care get humane treatment. When an animal is in good health, it is considered to be comfortable, well-fed, free to exhibit its inherent qualities, and not experiencing unfavourable circumstances like pain, anxiety, or discomfort. A balanced diet, suitable housing, humane handling of each animal, humane slaughter, disease prevention, management of animals, veterinary care when animals are ill, and animal care are all necessary for good animal wellbeing. Ensuring the comfort and safety of animals is a human responsibility, and it encompasses all facets of proper animal care. Giving animals a high quality of life is the main objective of animal welfare. In the 1950s, the phrase "quality of life" first appeared in the geographical and medical domains related to humans.

In India, animal welfare refers to the way that domestic pets, wildlife, farm animals, and animals used in research are treated, cared for, and legally protected. India has strong religious and cultural traditions that value animal compassion, but the nation still has a long way to go in guaranteeing the wellbeing of its animal population. The present status of animal welfare in India is critically examined in this article, which also looks at areas that need immediate attention and explores legal frameworks, enforcement strategies, and public attitudes.

All facets of animal wellbeing are included in animal welfare. Primarily, it aims to tackle five essential freedoms for adequate care of animals.

The five freedoms are:

- **Nutrition:** freedom from thirst and hunger
- **Environment:** freedom from discomfort by providing appropriate shelter
- **Health:** freedom from injury and disease by providing proper treatment
- **Behavior:** freedom to express their own kind by providing proper facilities
- **Mental state:** freedom from fear and mental suffering.

Every animal has the right to live a happy, healthy life filled with opportunities for their overall well-being. In India, we revere animals as gods and goddesses in addition to using them for agriculture and animal husbandry. Animal welfare is protected by the Indian Constitution and a number of other laws. Besides from that, the Indian Supreme Court has supported animal rights on a number of instances. In the case of WWF v. Union of India, the Supreme Court of India considered ecocentrism, rather than anthropocentrism into consideration for a more sustainable and better future. The belief that humans and non-humans are integral components of the same eco-system is fostered by ecocentrism, which takes into account the intrinsic values of both.

Despite India's strong efforts to uphold and safeguard animal rights, animal abuse is nevertheless a common occurrence there. Every day, there are numerous instances of animal abuse, but they are typically not recorded. Only strict laws, everyone's active engagement, and social consciousness can lessen this situation. Act as a voice for those who lack one.

Animal Protection Laws in India:

1) **Constitutional Clauses and Provisions:** Numerous articles of the Indian Constitution were created to uphold and safeguard the rights of animals in the country.
   a) The Directive Principles of State Policy, Article 48 states The State shall endeavour to organise agriculture and animal husbandry on modern and scientific lines and shall, in particular, take steps for preserving and improving the breeds, and prohibiting the slaughter of cows and calves and other milch and draught cattle.
   b) Article 48A declares, Protection and improvement of environment and safeguarding of forest and wild life, and states that the state shall make effort in protecting and safeguarding the environment the forest and the wild life.
   c) Part IVA of the Constitution declares Fundamental Duties of every citizen of India, which imposes a duty on the citizens under Article 51A (g) to protect and improve the natural environment.
   d) The Constitution of India also imposes a power on the parliament and the legislatures of states under Article 246 with Seventh Schedule of the Constitution to make laws for the prevention of cruelty to animals and for the protection of wild animals and birds.

e) Under Article 243G read with Eleventh Schedule of the Constitution empowers the Panchayet to make laws on Animal husbandry, dairying and poultry.

f) Article 243W read with Twelfth Schedule of the Constitution, makes provisions for the Municipalities to make laws for cattle pounds and for the prevention of cruelty to animals.

2) Indian Penal Code, 1860

a) Section 428 of the Indian Penal Code, 1860, provides punishment for committing mischief by killing or maiming any animal of the value of 10 rupees with imprisonment for two years or with fine or with both.

b) Section 429 of the Indian Penal Code, 1860, deals with the punishment for killing or maiming any described animal of any value or of the value of 50 rupees or upwards with the imprisonment of five years or with fine or with both.

3) India has a vast legal system designed to safeguard animals.

a) **The Prevention of Cruelty to Animals Act (PCA), 1960**, is the main piece of legislation that defines crimes against animals and specifies the consequences for breaking them. The major task force working for the animal welfare is "The Animal Welfare Board of India" which is a statutory advisory body on Animal Welfare Laws and promotes animal welfare in the country. Established in 1962 under Section 4 of the Prevention of Cruelty to Animals Act, 1960 (No. 59 of 1960). the Animal Welfare Board of India was started under the stewardship of Late Smt. Rukmini Devi Arundale, well known humanitarian. From ensuring that animal welfare laws in the country are diligently followed; to provide grants to Animal Welfare Organizations and advising the Government of India on animal welfare issues.

The Board has been the face of the animal welfare movement in the country for the last 60 years. Through its services, Board ensures that animal welfare laws in the country are diligently followed, provides grants to Animal Welfare Organizations and advises the Government of India on animal welfare issues. The Board consists of 28 Members including 6 Members of Parliament (2 Members of Parliament from Rajya Sabha and 4 Members of Parliament from Lok Sabha). The Board consists of 28 Members. The term of office of Members is for a period of 3 years. In addition, the National Institute of Animal Welfare in Ballabhgarh, Haryana, is a subordinate organisation that offers instruction and training.

The Committee for Control and Supervision of Experiments on Animals (CCSEA) is a statutory Committee of Department of Animal Husbandry and Dairying (DAHD), Ministry of Fisheries, Animal Husbandry and Dairying (MoFAH&D) constituted under the Prevention of Cruelty to Animals (PCA) Act, 1960. CCSEA is duty bound to take all such measures as may be necessary to ensure that animals are not subjected to unnecessary pain or suffering before, during or after performance of experiments on them. For this purpose, the Committee formulated the Breeding of and Experiments on Animals (Control & Supervision) Rules, 1998 (amended in 2001 & 2006) to regulate the experimentation on animals.

b) **The Wildlife Protection Act of 1972** also provides protection for wild species and their natural environments.

4) Government Initiatives: Thankfully, the issue of animal cruelty has recently drawn attention from around the globe and the Indian government is taking it seriously. To ensure that there is no cruelty in the nation, the government has taken certain significant steps.

- Ban On Captive Dolphin Shows: In May 2013, the Ministry of Environment & Forest, Government of India, prohibits the capture and use of Dolphins for entertainment purposes in the country. It also issued a policy and directed the state governments to deny the permission to any Dolphinarium
- Ban On Imports of Animal Tested Cosmetics: In Nov, 2014, India became the first South Asian Nation to impose ban on imports of animal tested cosmetics in India. By this bold step India has become the first cruelty-free zone in South Asia.
- Jet Airways Commits to Protecting Shark Population and Marine Eco-System: After taking the appeal of Humane society International/ India into consideration, Jet Airways banned the shipment of shark fins on its carriers to protect the worldwide declining population of sharks.
- Government Orders to Prevent the Illegal Movement of Animals to Nepal: On November 4, 2014, the Ministry of Home Affairs, Government of India ordered the Paramilitary Sashatra Seema Bal to prevent the illegal movement of animals to Nepal and prohibit the cattle transport without license. This act works as a reaction against the Gadhimai Festival in Nepal, where Lakhs of animals were sacrificed and 70% of those animals were illegally imported from India.
- To protect and conserve the wildlife, to protect the biodiversity, to protect the ecological stability and to maintain the ecosystem the Government of India has invested in various conservation projects. The goal of wildlife conservation initiatives is to maintain and safeguard the dwindling numbers of diverse extinct creatures. In India, the goal of Project Tiger is to preserve tigers. The Indian government started this tiger conservation initiative in 1972. The Indian government launched the "project elephant" in 1992 with the goal of protecting elephants and their natural environments while also fostering the development of the species in a number of ways. The United Nations Development Programme (UNDP) Sea Turtle Project was launched by the Wildlife Institute of India, Dehradun in November 1999 with the goal of conserving Olive Ridley turtles (Sharma, 2019). Another effective initiative by the Indian government to preserve Indian crocodiles is the conservation project.

In addition to numerous laws and agreements, the Indian courts actively contribute to the defense, upholding of animal rights and welfare. In addition to these laws, regulations, and rules, there are roughly 294 accredited animal welfare groups in India that support the preservation, defense, and rights of animals. Moreover, these campaigners for animal welfare and non-governmental organizations (NGOs) are essential in bringing about change in India. Advocating for improved animal protection laws, raising awareness, and rescuing and rehabilitating distressed animals are the tireless efforts of organizations such as People for Animals and the Blue Cross of India.

Conclusion:

Although India has made great progress toward holistic animal welfare, obstacles still exist. It is still difficult to strike a balance between economic growth, environmental preservation, and animal rights. Concerns regarding the treatment of animals reared for food production are brought up by the expansion of industrial farming, for example. The deeply ingrained notion of "ahimsa" in Indian spiritual traditions might act as a compass in addressing this issue.

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Popular Article

Poultry Waste Management in India: A Growing Challenge

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Introduction:

Poultry is one of the fastest-growing segments of the agricultural sector in India today. As crop production alone may not sufficient to address the food security challenges posed by the rapidly growing population, poultry production has emerged as a vital solution for fulfilling dietary needs. Currently, India ranks as the world's third-largest egg producer, the fourth-largest producer of chicken, and the fifth-largest in poultry meat production. As the poultry industry expands, it faces increasing challenges in managing the waste generated from production. It has been noted that if waste needs to be transported to a disposal site, it must be placed in sealed containers to prevent spillage. Globally, over 90% of poultry waste is typically spread on land near poultry farms. The poultry industry generates significant amounts of solid waste, including bedding material, excreta, feed, feathers, hatchery waste, mortality waste, and wastewater comprising feces, urine, sawdust, and residues from drugs and pesticides used in disinfecting chicken houses and abattoirs. Therefore, proper disposal and management of this waste are crucial for minimizing risks and maximizing the advantages of the poultry industry. Various techniques are available for managing and disposing of poultry waste to recycle nutrients and mitigate potential hazards. This article highlights different methods aimed at effective management and disposal of poultry waste, emphasizing the importance of sustainable practices in the poultry industry.

Poultry Litter/Manure Management:

Poultry litter and manure are the primary waste products from poultry farming, typically consisting of a mix of poultry manure, bedding materials such as wood shavings, and any spilled feed. It is estimated that a single poultry bird generates about 1 kg of litter and manure waste over a growth period of approximately 47 days.

Poultry manure is rich in essential nutrients, making it a valuable organic fertilizer that supplies key plant nutrients, including nitrogen (N), phosphorus (P), and potassium (K). When poultry litter is applied to

agricultural soil, it enhances organic matter, which in turn improves the soil's ability to retain water and its overall structure. Conducting a soil analysis is crucial to identify the correct balance of N-P-K and calcium (Ca) for the specific crops being grown. Although poultry litter contains many of the important macronutrients typically found in costly commercial fertilizers, its NPK ratios may not always align perfectly with the nutrient requirements of the soil. Various waste management strategies exist for handling poultry litter, with one of the most common being its application to land as an organic fertilizer.

As Fertilizer:

Proper management and handling of manure can enhance or substitute for commercially purchased fertilizers. Using poultry waste as manure for crop production is a preferred method for recycling nutrients. It is estimated that poultry excretes approximately 65.5% of nitrogen, 83.5% of potassium, and 68.5% of phosphorus from their nutrient intake, which contributes positively to crop yield. Additionally, poultry manure contains other important elements such as calcium, magnesium, sulphur, boron, molybdenum, cobalt, copper, iron, manganese, and zinc, which are often lacking in commercial fertilizers.

Typically, manure is stored on farms for at least a month before disposal; however, this storage period can lead to a loss of nearly 40% of nitrogen, diminishing the manure's effectiveness. In one study, chicken manure was applied to sweet potato cultivation, and it was recommended that small-scale farmers should avoid using excessive amounts of chicken manure, as higher levels could promote excessive vegetative growth at the expense of tuber development.

Livestock Feeds:

Processed poultry litter is incorporated into the diets of various livestock, including poultry, swine, lambs, ewes, lactating cows, wintering cattle, and brood cows. Poultry feathers, which are over 90% protein, serve as an excellent source of hydrophobic amino acids such as cysteine, arginine, and threonine. These feathers are often processed into feather meal, which is utilized in animal feed, organic fertilizers, and feed supplements.

Bioenergy Production:

Poultry manure and litter are abundant in organic matter, making them suitable for conversion into bioenergy. One common method for bioenergy production is water flushing, where manure undergoes anaerobic digestion, resulting in a gas mixture with varying levels of combustible methane. Biogas generated through this process can be utilized as fuel for engines, electricity generation, and other energy-consuming applications. Additionally, products processed anaerobically are highly suitable for land treatment and as feed supplements.

Rendering:

Rendering is a process that applies heat to extract fat from meat, making it particularly suitable for the disposal of high-risk materials. The products generated through rendering can be utilized in animal feed, as fertilizers, or further processed through anaerobic digestion or composting. During this process, materials are subjected to a temperature of 133°C for at least 20 minutes at 3 bars, or an alternative heat treatment, to render them appropriate for fertilization and feeding. This heat treatment not only extends the shelf life of the resulting

products by reducing moisture and eliminating microorganisms but also allows rendered feed products to be used in the chemical industry or as fuel. Additionally, slaughterhouse by-products are preserved with formic acid, which is a good source of proteins and vitamins and is commonly used in animal feed.

Anaerobic Digestion:

Anaerobic digestion is a biological process that breaks down organic matter to produce methane, which can serve as a bioenergy source to replace fossil fuels, thereby reducing carbon dioxide emissions. This method also decreases pathogens and odors, requires minimal land for treatment, and is effective for handling wet and pasty wastes. Additionally, any emissions to air, water, and land from this process can be effectively controlled. Most nutrients remain in the treated material, allowing for their recovery for agricultural or feed use.

Bio Diesel:

Slaughter house wastes like feathers, blood, and innards are being processed and utilized as high-protein animal feed sources or as fertilizer due to its high nitrogen content. It is estimated that these wastes contain up to 12 per cent fat. Environmental friendly processes are developed for the production of biodiesel from feather meal. In biodiesel production, primarily fat is extracted from feather meal in boiling water (70°C) and subsequently trans-esterified into biodiesel using potassium, nitrogen and methane; 7-11% biodiesel (on a dry basis) is produced in this process.

Byproducts from slaughterhouses, such as feathers, blood, and innards, are processed and utilized as high-protein animal feed or fertilizers due to their significant nitrogen content. These wastes are estimated to contain up to 12% fat. Environmentally friendly methods have been developed for producing biodiesel from feather meal. In this process, fat is extracted from feather meal using boiling water at 70°C, and then it undergoes transesterification with potassium, nitrogen, and methane, resulting in the production of 7-11% biodiesel (on a dry basis).

Recycling Poultry Waste:

Utilizing poultry waste as manure for crop production has become the preferred method for nutrient recycling. Recently, poultry nutritionists have been investigating the possibility of recycling poultry waste as feed for the birds themselves. Poultry droppings, previously viewed solely as waste or used sparingly as manure, could potentially serve as an alternative to conventional feed ingredients. These droppings are commonly referred to as dried poultry droppings, cage layer excreta, dried poultry waste, or dried poultry manure. Reports indicate that dried poultry waste contains around 30% protein, with approximately 60% derived from non-protein nitrogen sources, and it has a high mineral content.

Poultry waste is characterized by high water content, necessitating the development of cost-effective processing technologies to remove excess moisture and eliminate harmful pathogens. It is high in fibre but low in metabolizable energy, with a true digestibility coefficient of crude protein in poultry litter around 64%. The digestibility of specific amino acids varies, with valine at 24.7% and serine at 76.4%. Calcium and phosphorus absorption rates vary among individual birds, ranging from 1.2% to 45.3% for calcium and 7.5% to 46.2% for phosphorus. Poultry droppings may harbour various microbial organisms and molds, so processing is essential before they can be recycled as poultry feed. Additionally, drying and storage duration may help reduce the microbial load in fresh droppings.

Poultry Waste Disposal Methods:

The disposal of poultry carcasses poses significant environmental, biological, and financial challenges for the poultry industry. Globally, various methods are employed to dispose of poultry waste, including burial, rendering, incineration, composting, use as livestock feed, and conversion into fertilizer or energy sources. Each of these disposal options has its own advantages and disadvantages. For layers, rendering and incineration are the most common methods, while composting is the least frequently used.

In India, the predominant waste disposal methods appear to be burial in landfills, burning, incineration, and utilization as fertilizer in gardens and arable land.

Challenges Of Poultry Waste Management:

1. **Economic Implications**: The costs associated with implementing effective poultry waste disposal methods currently fall entirely on farmers, making them unaffordable and unsustainable.
2. **Lack of Government Policies**: There is a noticeable absence of government regulations regarding appropriate poultry waste management practices, which exacerbates the issue.
3. **Lack of Awareness**: Many poultry farmers lack knowledge and information about effective waste management practices. This gap can be addressed by establishing extension services to provide guidance and education.
4. **Modern Innovations**: The challenge of leveraging modern innovations to convert poultry waste into energy, biogas, and other usable resources is primarily driven by biotechnology. However, these methods have yet to be fully adopted in India as a means of treating poultry waste.

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Popular Article

Nanoparticles: Tiny but Mighty Tool against Plant Pathogens

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Abstract:

Plant pathogens are an unavoidable nuisance to the crops that ultimately hinders the economy of a nation. To manage the plant diseases time to time new methods and technologies are being developed and practiced. Fungicides serve to be one of the most successful management strategies but it comes with some negative aspects like increased pressure on environment and development of resistance in plant pathogens. So new advanced sciences like use of nanoparticles are being utilized as alternate methods to combat plant pathogens. Nanotechnology has the potential to revolutionize disease management in agriculture through the development of nanopesticides. These offer key benefits including improved solubility of poorly water-soluble pesticides, enhanced bioavailability, and reduced toxicity when loaded onto nanoparticles. Nanopesticides also allow for controlled and target-specific delivery, increasing efficacy while minimizing environmental impact. Other advantages include extended shelf-life, pH-dependent release, and smart delivery of RNAi molecules, enhanced UV stability, and rain-fastness. Additionally, nanopesticides offer selective toxicity, improving pest control precision and overcoming pesticide resistance. These innovations position nanoscale materials as critical tools in the agritech revolution, advancing sustainable and effective crop protection.

Keywords: Fungicides, Nanotechnology, Nanopesticides, sustainable, bioavailability

Introduction:

Reduction in crop production is attributed to several biotic and abiotic factors. The biotic factors primarily comprise of pests including insects, mites, birds, rodents and many more; pathogens like bacteria, fungi, virus, nematodes etc. and several kinds of weeds. The abiotic factors include vagaries of nature, environmental constraints and nutritional disorder to name a few. Among these the major constraint in successful crop production is the losses incurred due to biotic agents among which plant pathogens possess a serious and growing threat to the crop cultivation. Crop productivity is severely reduced by plant diseases and pests, which

are thought to cause annual losses of 20% to 40% worldwide. The use of pesticides, including fungicides, herbicides, and insecticides, is a major component of modern pest management. Despite having numerous benefits, such as being readily available, acting quickly, and being dependable, pesticides can cause harm to non-target organisms, encourage the resurgence of pest populations, and lead to the development of resistance. In addition, it is estimated that 90% of pesticides applied are lost during or following application. Consequently, there's more incentive to create pesticides that are less hazardous to the environment and work well at a lower cost (Ghormade et al. 2011). The solution to this is the start of a new effective domain, i.e., use of nanotechnology and nanoparticles to substantially minimize the hazardous effects of the agro chemicals. Nanotechnology as a growing science in agriculture has immense potential in managing agricultural issues.

Plant diseases pose a serious risk to agricultural output, with an annual economic loss of nearly $220 billion (FAO 2022). Future crop losses are predicted to rise as a result of climate change exacerbating this issue. There are control methods available for managing plant diseases. But the inefficiency of pesticide applications and delivery is a major worry. For instance, according to Pimentel and Burgess (2012), more than 50% of pesticides applied by air do not reach the intended target crops, posing serious risks to the environment, nontarget organisms, and applicators (Schäfer et al. 2019). As a result, new technologies are desperately needed to improve the efficacy and delivery efficiency of pesticides, and nanotechnology offers promise as a means of addressing these inefficiencies.

Nanotechnology For Plant Disease Management:

Information from physics, chemistry, natural science, and other disciplines is incorporated into the flexible field of nanotechnology. The operation or assembly of discrete atoms, molecules, or molecular collections into structures to form material manoeuvres with innovative or incredibly diversified assets is what Joseph and Morrison (2006) defined as nanotechnology. By using cutting-edge tools for prompt infection detection, targeted treatment, enhancing vegetation's capacity to absorb nutrients, preventing contamination and withstanding environmental stresses, and developing dynamic handling plans, among other things, the application of nanotechnology in agriculture has the potential to transform the field. The agronomic production will be assisted by intelligent delivery systems and sensors to combat viral infections and subsequent harvesting.

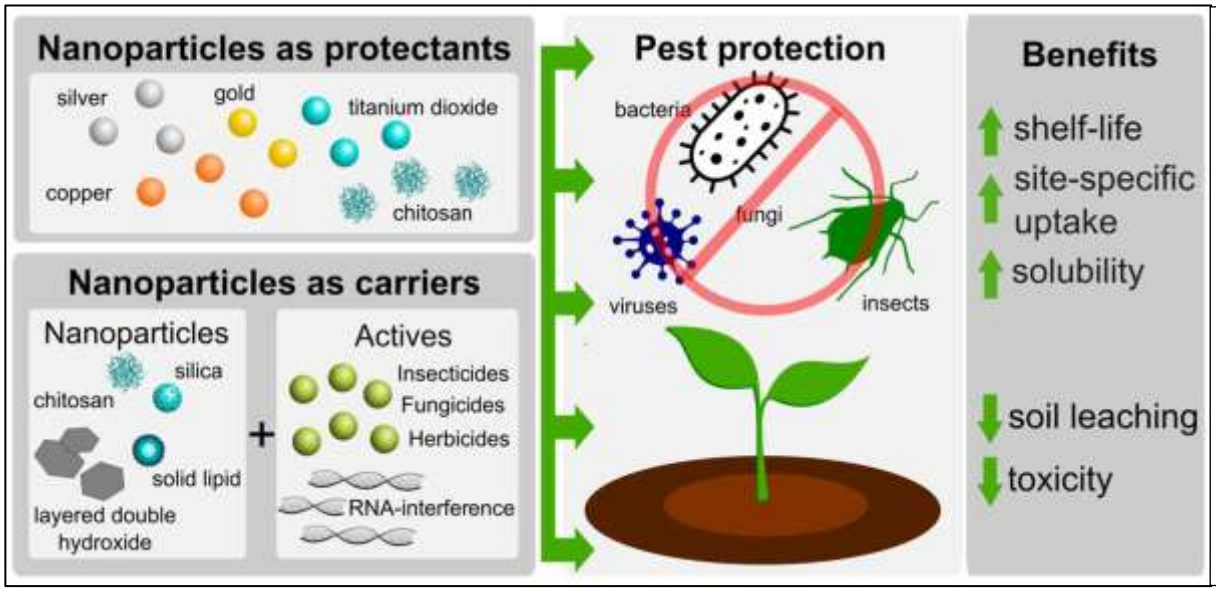

Fig 1: Nano materials as protectants or carriers to provide crop protection (Worrall et al. 2018).

Nanoparticles As Carriers Against Plant Pathogens:

Nanoparticles are increasingly being used as carriers to enhance the effectiveness of agricultural formulations, such as insecticides, fungicides, herbicides, and RNAi-inducing molecules. These nanoparticles entrap, encapsulate, absorb, or attach active molecules to protect them, improve their solubility, and ensure a controlled release. Silica nanoparticles (e.g., porous hollow silica nanoparticles or mesoporous silica nanoparticles) are widely used due to their customizable size, shape, and structure (Mody et al. 2014). They load pesticides into their inner core, protecting the active molecules from degradation, such as by UV light, and enabling a sustained release. Silica is also known for its role in enhancing plant tolerance to stress, making it a natural choice for pest control formulations. Chitosan nanoparticles are hydrophobic and typically require blending with other materials to improve solubility. Their ability to adhere to plant surfaces, such as leaves and stems, extends the contact time and facilitates the uptake of active molecules. Chitosan's reactive groups allow modifications that enhance its properties as a carrier (Kashyap et al. 2015). Solid lipid nanoparticles (SLNs) are lipid-based and solid at room temperature, serving as a matrix to entrap lipophilic molecules without organic solvents (Ekambaram et al. 2012) However, SLNs have low loading efficiency and may experience leakage of the active ingredient during storage. Despite this, they provide controlled release of active molecules. Layered double hydroxides (LDHs) are clay nanoparticles that trap active molecules between their layers and break down under acidic conditions. These nanoparticles help transport biologically active materials across plant cell walls.

These nanoparticles have been explored as carriers in plant disease management, particularly for fungicides. Research on nanofungicides has demonstrated that nanoparticle formulations can improve the stability and water solubility of active ingredients, reduce volatilization, and provide slow, sustained release of fungicides. Studies have shown that nanoparticle-based formulations can be as effective, or even superior, to conventional fungicides, particularly when protecting against decay or infection over long periods. For instance, tebuconazole, a fungicide, was successfully loaded into bacterial ghosts, increasing its adherence to plant surfaces and enhancing its performance against fungi under rain conditions. Pyraclostrobin, another fungicide, was loaded onto chitosan-lactide nanoparticles, showing enhanced inhibition of fungal pathogens over time. Nanoparticles have also been used to encapsulate essential oils with antifungal properties, enhancing their stability and antifungal activity over extended periods. Studies have demonstrated that encapsulating fungicides like chlorothalonil and tebuconazole into nanoparticles significantly reduces the amount of active material required while maintaining efficacy. For example, nanoparticle-loaded fungicides were able to protect wood from fungal decay with reduced application rates. Nanoparticles have also shown promise in reducing pesticide leaching in soils, improving soil retention of active ingredients, and minimizing environmental contamination. Slow-release nanoparticle formulations, such as calcium carbonate carrying validamycin, have been shown to improve long-term efficacy compared to the active ingredient alone. Research on the distribution and dissipation of pesticide-loaded nanoparticles in plants has shown minimal accumulation in edible parts, highlighting the potential safety of nanoformulations for agricultural use (Liu et al. 2002).

Nanoparticle And Their Use Against Plant Pathogens:

The first nanoparticle (NP) investigated for plant disease management was silver (Ag). Several studies, including those by Park et al. (2016), focused on the early use of silver nanoparticles (Ag NPs) to control powdery mildew,

all of which demonstrated significant disease suppression. Lamsal et al. (2011) reported that a concentration of 100 µg/mL provided control comparable to conventional fungicides and showed a curative effect. Further research has supported the effectiveness of Ag NPs in combating fungal pathogens, bacteria, and nematodes.

Copper nanoparticles (NP Cu) were a natural choice for plant disease management due to their long-standing use as contact bactericides and fungicides. However, serious research into NP Cu for disease control didn't begin until 2013, when foliar applications of NP CuO, Cu_2O, and Cu/Cu_2O composites were compared to conventional copper fungicides for managing late blight caused by Phytophthora infestans (Giannousi et al. 2013). Among the treatments, NP CuO at concentrations of 150–340 µg/mL showed superior performance. Since then, more advanced and refined Cu NP composites have been developed. For example, there was a novel approach introduced using engineered copper NP composites with core-shell structures, multivalent copper, and fixed quaternary ammonium copper for managing bacterial spot caused by copper-resistant Xanthomonas perforans. Additionally, the use of Cu as a nanofertilizer to enhance disease resistance has been explored across various plant-disease systems, including asparagus with Fusarium crown and root rot, chrysanthemum with Fusarium wilt, eggplant with Verticillium wilt, soybeans with sudden death syndrome, tea with red root rot, tomato with Fusarium wilt, and watermelon with Fusarium wilt (Elmer et al. 2018).

Zinc nanoparticles (Zn NPs) have been known to possess antibacterial activities against a range of fungal diseases, bacteria, and viral illnesses. Nonetheless, there are still few field studies demonstrating a discernible decrease in illness. Zinc nanoparticles (Zn NPs) have been used to control Fusarium graminearum in sorghum, Cercospora leaf blight in sugar beetroot and bacterial leaf spot on roses. ZinkicideTM, a zinc-based nanoproduct, is presently pending registration to be used in the management of citrus canker, which is caused by Xanthomonas citri subsp. citri. According to field trials, ZinkicideTM was more successful than conventional bactericides like cuprous oxide (Cu_2O) and blends of cuprous oxide and zinc oxide (Cu_2O/ZnO) in reducing the occurrence of disease. Furthermore, ZinkicideTM treatments were observed to be efficacious in inhibiting melanose (Diaporthe citri) and citrus scab (Elsinoe fawcetti) on grapefruit (Graham et al. 2016).

Sulphur (S), aluminium oxide (AlO), magnesium oxide (MgO), titanium oxide (TiO), and ceO have all shown promise in controlling plant diseases in a variety of systems. The majority of research has connected the application of these nanoparticles to specific adjustments in the defence systems of the host plant. Furthermore, these elements' nanoparticle forms were typically more effective at promoting plant health than their bulk or salt forms, frequently requiring much less of the active metal to achieve the same or superior results (Elmer et al. 2018).

Nanoparticles And RNAi Against Plant Pathogens:

The RNA interference (RNAi) pathway presents a promising method for managing plant pathogens. RNAi, a natural defense mechanism in plants, is triggered by double-stranded RNA (dsRNA), which is processed into small interfering RNA (siRNA) by Dicer-like enzymes. These siRNAs guide RNA-induced silencing complexes (RISCs) to degrade pathogen RNA, preventing its translation and curbing infection. While RNAi was initially deployed via genetic modification, concerns over genetically modified organisms (GMOs) have spurred research into alternative delivery methods, such as topical applications of dsRNA. However, topical dsRNA faces challenges like environmental degradation and poor uptake by target pathogens. To improve effectiveness, nanoparticles are

being explored as carriers of RNAi-inducing molecules. Nanoparticles such as LDH (layered double hydroxide) have been used to protect plants from viral pathogens. For example, a single spray of dsRNA-loaded LDH nanoparticles, called BioClay, protected plants from cucumber mosaic virus (CMV) and pepper mild mottle virus (PMMoV) for 20 days, even affecting new leaves. This highlights the potential of nanoparticle-assisted RNAi for managing plant pathogens. In another study, dsRNA delivered via nanoparticles was shown to be successfully absorbed through plant roots, inducing gene silencing in Arabidopsis. These advances suggest that nanoparticles can enhance the stability and delivery of RNAi-based treatments, offering a novel approach for protecting crops from viruses, fungi, and other pathogens (Thairu et al. 2017).

Conclusion:

Nanotechnology is becoming an increasingly vital tool in plant disease management, with engineered nanoparticles (NPs) being used as both bactericides and fungicides, as well as nanofertilizers to boost plant health. So far, the majority of research has focused on the antimicrobial properties of nanoparticles, particularly those of silver (Ag), copper (Cu), and zinc (Zn), and their ability to enhance plant defense responses. Nanoparticles are expected to play a key role in suppressing plant diseases in both greenhouse and field environments. One significant benefit of using nanotechnology in plant disease management is the considerable reduction in the amount of active metals entering the ecosystem, as compared to conventional metal-based fungicides. However, a challenge in applying nanotechnology to plant pathology is that nanoparticles often behave differently across various plant-pathogen systems, necessitating a tailored approach for each specific disease. Additionally, nanomaterials tend to aggregate over time, which reduces their efficacy, thus requiring ongoing innovation in the development of new nanocomposites and formulations. Chemists will play a crucial role in overcoming these challenges by designing nanoparticles that remain stable and effective in diverse environments. With the pressing challenges faced by modern agriculture, the development and deployment of nano-enabled strategies for disease suppression are poised to be critical tools in ensuring and sustaining global food security.

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Popular Article

Urea In Animal Feed: A Source of Protein

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Introduction:

About 70 per cent of the cost of raising livestock is spent on animal feed. A good animal feed and green fodder are required for the health and production of animals, but green fodder is not available throughout the year but an adequate amount of protein can be provided in the diet of animals. Therefore, along with dry fodder the animals should also be given protein sources which are mainly obtained from chuni, bran, khaliya and urea sources. Urea is a non protein nitrogen compound. Urea provides the extra nitrogen required for the use of dry matter. Nitrogen must be present to maintain adequate amounts of ammonia in the rumen. Urea contains about 46 percent nitrogen. One kilogram of urea contains 7-8 kilograms of nitrogen. Converts urea into protein through the production of ammonia and carbon dioxide in cattle and other ruminants, Urea enhances the nutrition, taste and digestibility of husk.

Methods of Feeding Urea to Animals:

1. Feeding urea with grains - In this method, 1 kg of urea is fed with 100 kg of grains. Before feeding the animals, the grains and urea should be soaked and fed. The maximum amount of urea can be fed to the animals up to 2 percent of the grain.

2. Making a solution of urea and jaggery - in this method 150 to 250 grams of urea and 250 grams of jaggery both are mixed well in water and fodder is treated. This solution is useful for 10 kg of fodder.

3. Treatment of fodder by urea -In this method, 4 kilograms of urea is treated 100 kilograms of fodder by making a solution in 50 litres of water and after spraying the urea solution well on the fodder, making a surface of 100 kilograms of fodder on top of it, spraying the solution of 4 kilograms of urea again on top of it, then covering the heap of treated fodder with a plastic sheet, this treated fodder becomes useful for the animals in 20-25 days. Before feeding this treated fodder, the fodder should be spread in the open air so that the smell of urea is removed.

4.Urea - molasses liquid mixture - In this method 2.5 parts urea, 25 parts water, 1 part salt, 2 parts mineral salts, 92 parts molasses are mixed and a solution is prepared which is used to treat the fodder. The feed treated by this method is given to the animals according to 1 kg per 100 kg body weight.

5. To make urea - molasses mineral salts block - block all the mixture of 40 percent molasses, 12 percent urea, 5 percent salt, 6 percent mineral salts, 4 percent calcium oxide is mixed gradually. Then it is poured into a mold made of wood or metal, mixed with plastic and given the form of a brick. These bricks are ready in 24 hours which are used to feed the animals.

Amount Of Urea to Different Animals: -

- The amount of urea to sheep and goats should be given one percent of dry fodder.
- Cow and buffalo should be given 1 / 3 of the total protein in the form of urea.
- If the milch cow is giving less than 20 liters of milk then urea is given to it 2 percent of the total grain.
- If the milch cow is giving more than 20 liters of milk then it should not be fed urea because there is no synthesis of urea.
- Heifer, bull and low yielding animals should be fed 1.5 to 20 percent of urea grain.

Precautions While Feeding Urea: -

- Urea should be mixed well and fed.
- Urea should always be fed to adult animals, not to small animals.
- Never feed more than the recommended amount of urea.
- Calves less than six months should not be fed urea.
- Sick animals should also not be fed urea.
- Always make the solution of urea at the time of use. It should not be prepared before because the solution of urea prepared before has toxic properties which are harmful for the animals.
- Pregnant animals should not be fed urea.
- Urea-fed animals should be provided with adequate quantity of water in time as urea increases water use efficiency.

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