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57th Annual General Meeting (AGM)
&
65th National Symposium 2024

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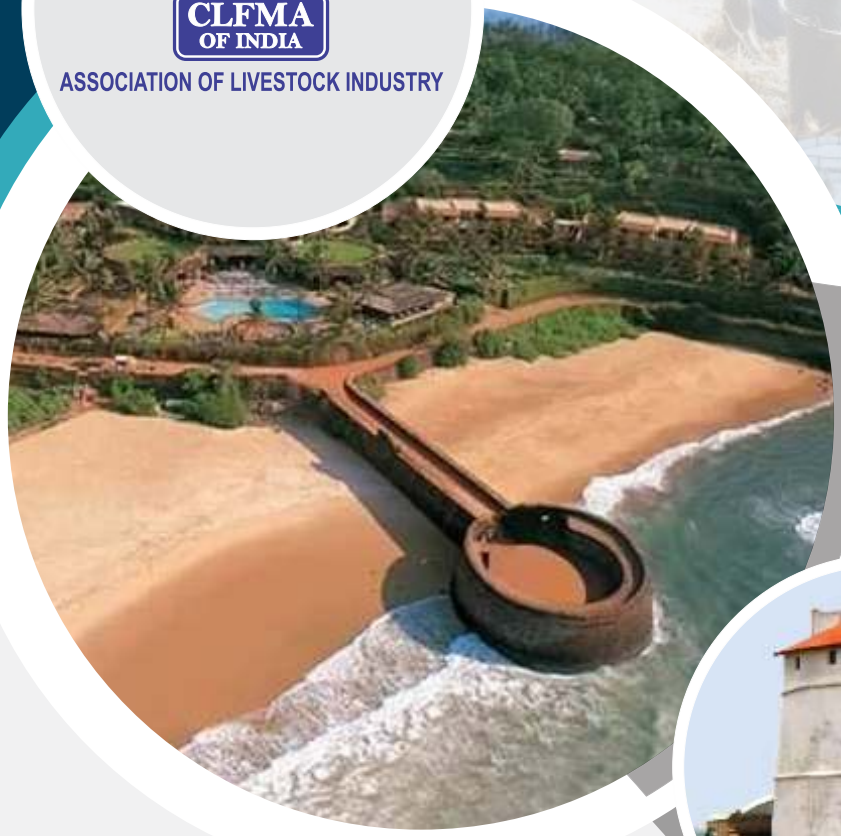

Theme
"Sustainable Livestock Sector: Threats, Challenges and Opportunities."

Souvenir

20th & 21st September 2024

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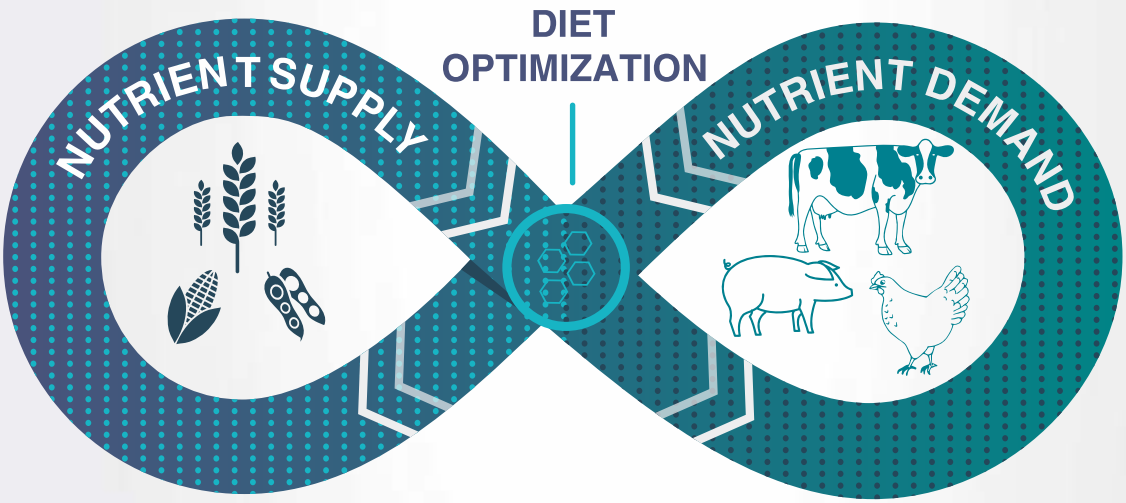

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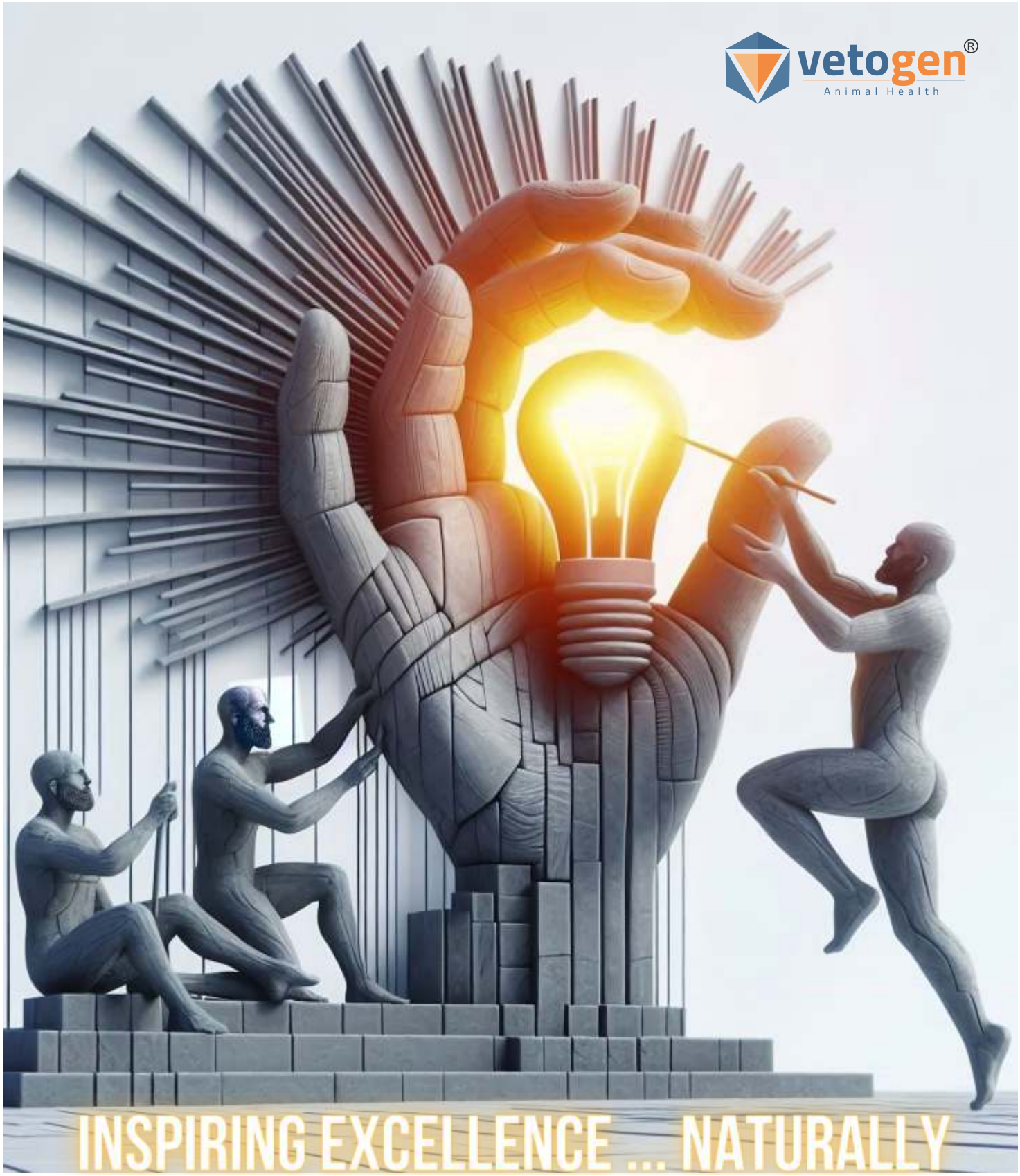

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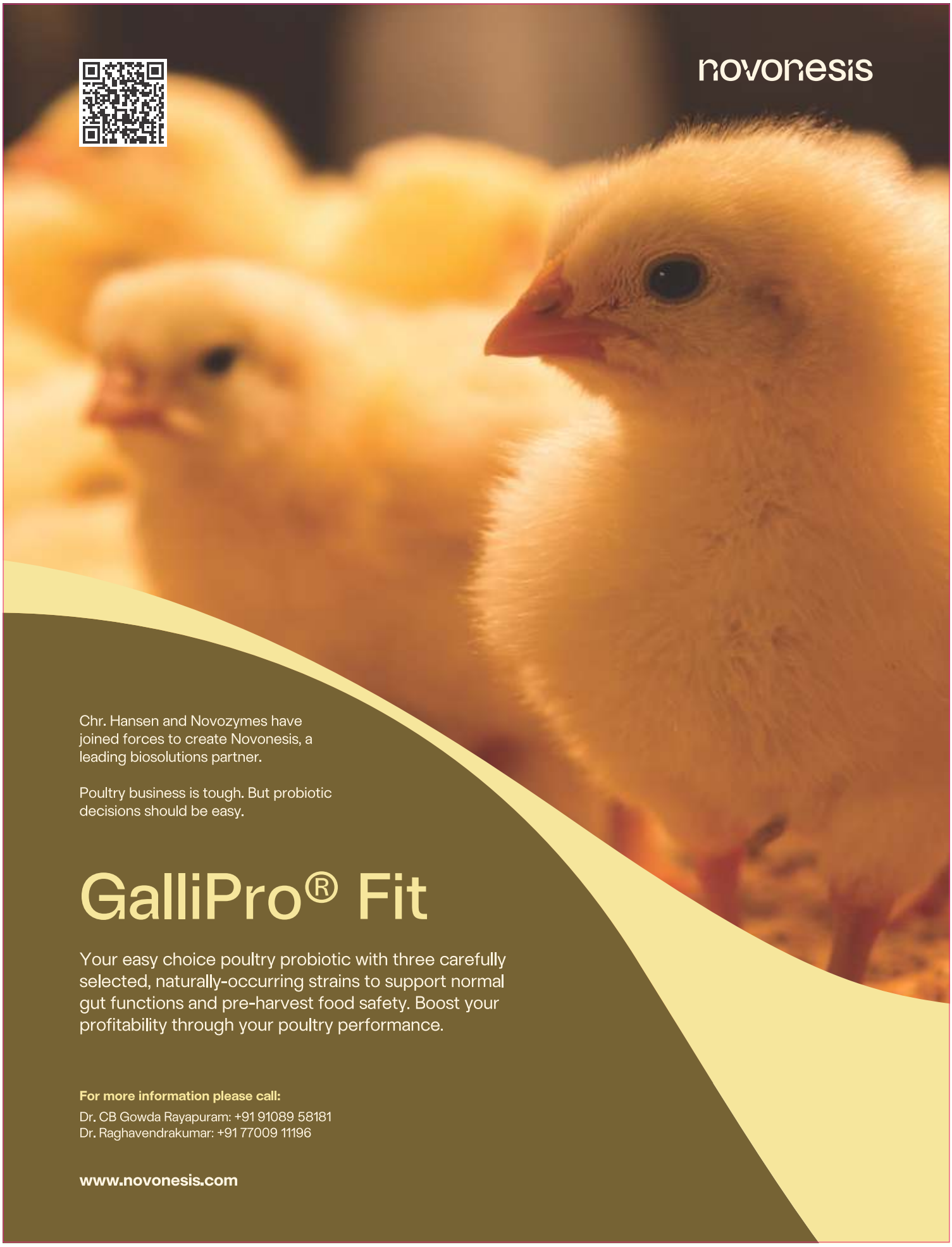

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Minister of Panchayati Raj and
Minister of Fisheries, Animal Husbandry and Dairying
Government of India

DO. No. 203 MIN PR&FAHD/2024

11th September, 2024

MESSAGE

I am delighted to know that the CLFMA OF INDIA is organizing the 57th Annual General Meeting and the 65th National Symposium 2024 on 20th and 21st September, 2024, at Goa. The theme for the year's symposium is "Sustainable Livestock Sector: Threats, Challenges and Opportunities",. 65th National Symposium 2024 will serve as a vital platform for stakeholders to engage in meaningful discussions and collaborations to shape the further of the livestock sector.

In the face fo growing environmental concerns, the livestock sector needs to navigate a complex landscape of sustainability challenges. Key threats include climate change, resource depletion, and biodiversity loss, which have significant impact on livestock production. Addressing these threats requires a holistic approach that integrates innovative practices and sustainable resource management to ensure the long-term viability of the sector.

In addition these environmental threats, the livestock sector faces various challenges such as animal health, food safety, and socio-economic pressure. Disease outbreaks can disrupt production, leading to economic losses and food insecurity. Improving animal health management, investing in biosecurity measures and enhancing traceability are essential steps to safeguard the sector against such challenges. Moreover, ensuring fair economic returns for farmers and other stakeholders is crucial for maintaining the social sustainability of the livestock industry.

Despite threats and challenges, there are significant opportunities to be explored. Technological advancement, such as precision livestock farming, use of alternate and novel raw materials offer new ways to enhance productivity and efficiency, while reducing the environmental footprint. Additionally, the rising consumer demand for ethically, sustainably and hygienically produced livestock products presents opportunities for differentiation and value addition. By embracing these innovations and shifting towards more sustainable practices, the livestock sector can play a crucial role in supporting food security, rural development, and economic growth. I commend CLFMA's commitment for making the livestock sector more dynamic and sustainable. I am confident the the 65th National Symposoium 2024 of CLFMA OF INDIA will provide valuable insights and beneficial for all stakeholders involved in the livestocks ector.

I extend my best wishes to the organizer for the success of the 65th National Sysmposium 2024

(Rajiv Ranjan Singh)

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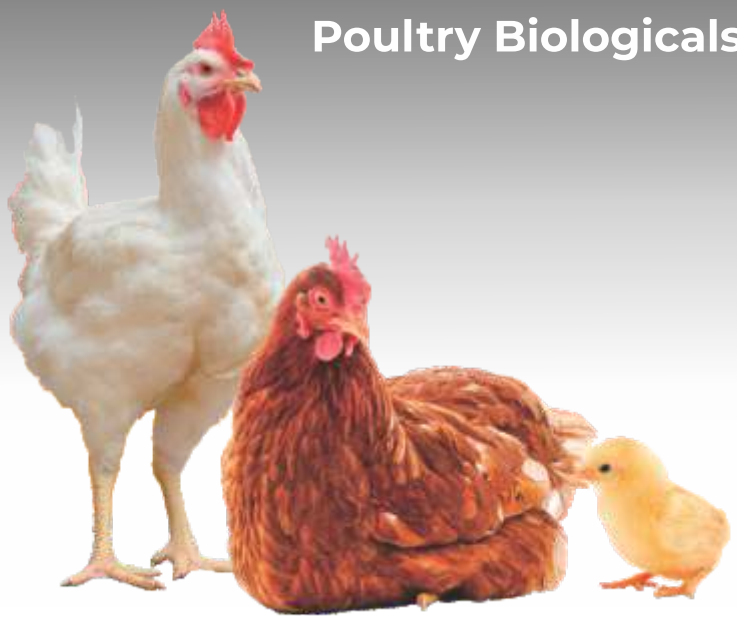

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भारत सरकार
MINISTER OF COMMERCE & INDUSTRY
GOVERNMENT OF INDIA

MESSAGE

I am delighted to learn that The Compound Livestock Feed Manufacturers Association (CLFMA) is organising the 65th National Symposium from 20th - 21st September, 2024 in Goa.

The livestock industry in India, being labor-intensive, provides employment to a large number of people, playing a significant role in the socio-economic upliftment of economically weaker sections of society while contributing notably to the country's GDP. Under the dynamic leadership of our Hon'ble Prime Minister Shri. Narendra Modi ji, India has undertaken several initiatives to enhance sustainable development, animal health and productivity. These include modernising the dairy sector, supporting integrated aquaculture and livestock practices, investing in infrastructure, promoting indigenous breeds and providing extensive training programs to build a resilient livestock industry.

For many decades, CLFMA has been at the forefront of the livestock industry in India, shaping policies for animal agriculture through insightful collaboration with both Central and State Governments. The Symposium will serve as a vital platform for fostering discussions on critical issues such as sustainability and technological advancements in the livestock sector, addressing pressing challenges and opportunities.

I congratulate CLFMA for organizing this event and wish the association continued success in all its future endeavors.

(Piyush Goyal)

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Prof. S. P. SINGH BAGHEL
Minister of State for
Fisheries, Animal Husbandry & Dairying
and
Panchayati Raj
Government of India

MESSAGE

I am pleased to extend my heartfelt greetings to CLFMA of India on the occasion of its 57th Annual General Meeting and the 65th National Symposium 2024. This event is a key activity in our journey towards fostering innovation, sustainability, and collaboration within India's livestock and fisheries sectors.

The theme of this year's symposium, "Sustainable Livestock Sector: Threats, Challenges and Opportunities," is highly relevant. India continues to excel in the fields of livestock, fisheries, and poultry. However, we face numerous challenges, including climate change, habitat degradation, and the need for sustainable resource management. This symposium offers a valuable platform for industry stakeholders to engage in meaningful discussions and share insights on navigating these challenges.

The Ministry of Fisheries, Animal Husbandry & Dairying remains committed to supporting initiatives that promote sustainability and innovation in these critical sectors. By adopting sustainable practices, improving resource efficiency, and leveraging advanced technologies, we can ensure that our industries continue to thrive while safeguarding the livelihoods of millions who depend on them. We recognize that the involvement of local communities is essential in implementing sustainable practices and ensuring the socio-economic well-being of those engaged in livestock, fisheries, and aquaculture activities.

I am confident that this symposium will generate valuable discussions, foster collaboration, and lead to actionable strategies that will benefit the livestock and fisheries sectors. Let us work together to build a resilient, sustainable, and prosperous future for all.

My best wishes for a successful and impactful Symposium !

Prof. S. P. Singh Baghel

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Government of India
Ministry of Fisheries, Animal Husbandry & Dairying
Department of Animal Husbandry & Dairying
218, A-Wing, Krishi Bhawan
New Delhi-110001

5th September, 2024

MESSAGE

The livestock sector is vital to India's economy, food security, and rural livelihoods. India is currently the world's largest producer of milk, second-largest in egg production, and eighth in overall meat production. The sector has shown a robust growth rate, with a CAGR of 7.38% from 2014-15 to 2022-23, highlighting its significance in the agrarian economy. Livestock's contribution to agriculture and allied sectors' Gross Value Added (GVA) rose from 24.32% in 2014-15 to 30.38% in 2022-23, accounting for 4.66% of total GVA.

However, the sector faces challenges such as emerging animal diseases, feed and fodder shortages, and climate change. Addressing these issues requires a national strategy supported by strong partnerships among stakeholders. Multi-stakeholder collaboration is essential for sustainable livestock growth, meeting global demand, and tackling environmental, social, and economic challenges.

The 65th National Symposium on "Sustainable Livestock Sector: Threats, Challenges, Opportunities," organized by CLFMA of India, is a significant initiative. It aims to generate creative solutions, particularly addressing feed and fodder challenges, ensuring the sustainable development of India's livestock sector.

(Alka Upadhyaya)

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Additional Secretary
Government of India
Ministry of Fisheries, Animal Husbandry & Dairying
Department of Animal Husbandry & Dairying
Krishi Bhawan, New Delhi-110001

MESSAGE

The livestock sector is a crucial component of our food system, significantly contributing to poverty reduction through livelihoods, food security, and economic development. According to the FAO, livestock accounts for 40% of the global agricultural output's value and supports the livelihoods of nearly 1.3 billion people. However, there is a pressing need to enhance the sector's sustainability, equity, and health practices.

In the current scenario, factors like rising incomes, changing diets, and population growth have driven increased demand, making livestock one of the fastest-growing agricultural sub-sectors in the country. This growth presents opportunities for small holders, start-ups and livestock businesses but also raises sustainability concerns, including environmental impacts and public health risks.

To address these challenges, Collaborative efforts among stakeholders are essential to drive sustainable growth, ensuring that the sector remains a resilient contributor to food systems while addressing environmental and social challenges.

I would like to appreciate the commitment of CLFMA to organize a National Symposium on "Sustainable Livestock Sector: Threats, Challenges, Opportunities," which is a significant step for promoting sustainable and climate-smart livestock investments in the country.

(Varsha Joshi)

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NICOLÒ CINOTTI
Secretary General
International Poultry Council

MESSAGE

The International Poultry Council salutes CLFMA of India as it kicks off its 65th National Symposium on "Sustainable livestock sector: threats, challenges and opportunities".

Seeking a balance between production and sustainability is becoming a live or die point for any industry globally, particularly for the livestock sector. While challenges such as climate change and biodiversity loss are threatening our planet and must become a priority in every stakeholder's agenda, we should not forget that all relevant forecasts for the next 20 years are calling the agrifood sector to feed more people than ever.

As I look at the theme of your Symposium, I cannot but envision in my mind what I think are the most relevant threat, challenge and opportunity we have before us.

The biggest threat is misinformation. Consumers, politicians, partners and even ourselves, we all base our choices on inputs we get from the outside. Access to information has never been as easy and quick as in the last decade, although some of the information circulating on the livestock sector are wrong. As livestock representatives, we must do our best to counterbalance those wrong information.

The biggest challenge is sticking to science. In a world and at a time where everything is becoming questionable, sticking to science is the only way forward, although sometimes not the easiest or the most appealing for communication. Counterbalancing emotional but incorrect narratives with science based messages is what will keep us busy the most in the near future.

The biggest opportunity is riding innovations. Artificial intelligence, regenerative farming, scientific and technological innovations, we must keep doors open and continuously ask for innovative solutions to full fill our mission in feeding the world.

IPC looks with great interest at events such as this Symposium as incubators of actionable and scalable innovative ideas and wishes a fruitful and successful Symposium to all the attendees.

(Nicolò Cinotti)
Secretary General
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Convenor Address

It is with immense pleasure that I welcome you all to CLFMA OF INDIA's 57th Annual General Meeting and 65th National Symposium, 2024. This year, we gather at the beautiful Hotel Novotel Goa Resort and Spa, Bardez, Goa, on the 20th and 21st of September, 2024.

I extend my sincere gratitude to our Chief Guest, Guests of Honour, esteemed dignitaries, distinguished speakers, key government officials, and participants from across the nation and beyond. Your presence is vital to the success of this event, and I am deeply thankful for your commitment to the cause we champion.

As I reflect on last year's Symposium, I am reminded of the invaluable insights and contributions from Hon'ble Ministers, senior policymakers, regulatory authorities, and prominent figures from both industry and academia. Their participation was instrumental in driving forward our shared vision for the livestock sector. I am confident that this year's event will be equally impactful and will set the stage for transformative discussions.

The theme for this year's Symposium, "Sustainable Livestock Sector: Threats, Challenges, and Opportunities," is both timely and of critical importance. The livestock sector, a cornerstone of India's agricultural economy, stands at a pivotal crossroads. The increasing demand for food, particularly protein sources like poultry, dairy, and aqua products, necessitates a careful navigation through a complex landscape of challenges while simultaneously seizing emerging opportunities.

The sustainability of the livestock sector faces significant threats from global issues such as climate change, biodiversity loss, and the depletion of natural resources. These challenges are particularly acute for the poultry, dairy, and aqua sectors, which are vital to India's food security and rural economy.

- Poultry Industry: Balancing high production efficiency with environmental impact and animal welfare concerns is a growing challenge.
- Dairy Sector: As a key provider of nutrition in India, the dairy sector grapples with feed availability, water scarcity, and greenhouse gas emissions.
- Aqua Sector: Sustainability of water resources and the health of aquatic ecosystems are pressing issues.

However, within these challenges lie significant opportunities. Technological advancements in precision farming, feed efficiency, and waste management offer the potential to greatly reduce the environmental footprint of livestock production. The adoption of regenerative agricultural practices and policies promoting sustainable development can lead to a more resilient and profitable sector. By prioritizing sustainability, we can enhance food security, improve rural livelihoods, and contribute positively to our ecosystems.

The primary objective of this Symposium is to exchange innovative ideas and explore these opportunities, ensuring the continued prosperity of the livestock industry. Discussions will focus on balancing productivity with environmental stewardship, improving animal welfare, and leveraging technological innovations to drive sustainable growth.

CLFMA remains steadfast in its commitment to transforming the insights from this symposium into actionable strategies. We will continue to support the Government of India and the livestock sector in their efforts to achieve sustainable development. The Government of India's initiatives demonstrate a strong commitment to uplift the dairy, poultry, and aqua sectors. Also, these initiatives play a crucial role in ensuring food security, generating employment, and contributing to the economy.

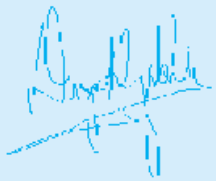
This symposium exemplifies our dedication to fostering a collaborative approach. By bringing together industry leaders, government officials, and international experts, we aim to chart a course for a sustainable future for the livestock sector.

I am confident that the 65th Symposium, 2024, will serve as a platform for the exchange of groundbreaking ideas that will propel the livestock sector to new heights.

I extend my deepest appreciation to our sponsors for their unwavering support of CLFMA and its initiatives. I also wish to thank the Office Bearers, Members of the Managing Committee, association members, and delegates for their continued dedication and active participation.

I eagerly anticipate the meaningful discussions and valuable partnerships that will emerge from this 65th National Symposium, 2024. Together, let us build a sustainable and prosperous future for the livestock sector.

With Regards,



Divya Kumar Gulati
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Chairman's Address

It is with great pleasure that I welcome you all to CLFMA OF INDIA's 57th Annual General Meeting and 65th National Symposium, 2024 scheduled to be held on the 20th and 21st September, 2024 at the Hotel Novotel Goa Resort and Spa, Bardez, Goa.

In last few years, CLFMA OF INDIA has established itself as the only Livestock Association in the Country, which represents all the Sectors Aqua, Dairy and Poultry, and serves as a Pivotal Link between the Livestock Farmers, the Industry and various Ministries and Departments of Government.

I extend my heartfelt gratitude to our Chief Guest, Guests of Honour, esteemed dignitaries, eminent speakers, key government officials, and participants from across the nation and beyond. Your presence is instrumental in making this event a resounding success.

Reflecting on last year's Symposium, we were privileged to host an unparalleled gathering of Hon'ble Ministers, senior policy makers, regulatory authorities, and prominent figures from both industry and academia. Their insights and contributions were valuable, and I am confident that this year's event will be equally impactful.

The theme for this year's Symposium is, “Sustainable Livestock Sector: Threats, Challenges, and Opportunities,” is both timely and crucial. The livestock sector, a cornerstone of India's agriculture, is at a pivotal juncture. With the growing demand for food, particularly protein sources like poultry, dairy, and aqua products, the sector must navigate a complex landscape of threats and challenges while seizing emerging opportunities.

Background on the Theme: The sustainability of the livestock sector is increasingly under threat from global issues such as climate change, biodiversity loss, and the depletion of natural resources. The

poultry, dairy, and aqua sectors, which are vital to India's food security and rural economy, face unique challenges in this regard. For instance, the poultry industry must balance high production efficiency with concerns about environmental impact and animal welfare. The dairy sector, a key provider of nutrition in India, grapples with issues related to feed availability, water scarcity, and greenhouse gas emissions. Similarly, the aqua sector must contend with the sustainability of water resources and the health of aquatic ecosystems.

However, these challenges also present opportunities. Technological advancements in areas like precision farming, feed efficiency, and waste management can significantly reduce the environmental footprint of livestock production. The adoption of regenerative agricultural practices and policies that promote sustainable development can lead to a more resilient and profitable sector. Moreover, by emphasizing sustainability, we can enhance food security, improve rural livelihoods, and contribute to the health of our ecosystems.

The primary objective of this Symposium is to exchange innovative ideas and explore these opportunities to ensure the continued prosperity of the livestock industry. The discussions will focus on how to balance productivity with environmental stewardship, improve animal welfare, and leverage technological innovations to drive sustainable growth.

CLFMA remains steadfast in its commitment to transforming the insights from this symposium into actionable strategies. We will continue to support the Government of India and the livestock sector in their efforts to achieve sustainable development.

The Government of India has implemented several initiatives to uplift the dairy, poultry and Aqua sector, recognizing their critical role in ensuring food security, generating employment, and contributing to the economy.

Here are some key initiatives for Dairy Sector, National Dairy Plan, Rashtriya Gokul Mission, Dairy Entrepreneurship Development Scheme (DEDS), etc. For poultry sector, Poultry Venture Capital Fund, National Livestock Mission, Animal Husbandry Infrastructure Development Fund (AHIDF), for Aqua Sector Pradhan Mantri Matsya Sampada Yojana (PMMSY), Blue Revolution,

Development of Marine Fisheries, Infrastructure, and Post-Harvest Operations, For Cross-Sectoral Support for all the three sectors i.e. Livestock Health and Disease Control Program, Kisan Credit Card (KCC), for Animal Husbandry and Fisheries, for Research and Development in all the three sectors Indian Council of Agriculture Research is there through its various institutes, ICAR conducts research in Dairy, Poultry, and Fisheries to develop new technologies, improve productivity and address challenges related to climate change, disease management, and feed efficiency. Overall, these initiatives reflect the Government of India's commitment to ensuring the sustainable growth and development of all the three sectors Dairy, Poultry and Aqua, ultimately contributing to the broader goals of food security, rural development and economic growth.

This symposium exemplifies our dedication to fostering a collaborative approach, bringing together industry leaders, government officials, and international experts to chart a course for a sustainable future.

I am confident that the 65th Symposium, 2024 will serve as a platform for the exchange of groundbreaking ideas that will propel the livestock sector to new heights. I extend my deepest appreciation to our sponsors for their unwavering support of CLFMA and its initiatives.

I also wish to thank the Office Bearers, Members of the Managing Committee, association members, and delegates for their continued dedication and active participation.

I look forward to the meaningful discussions and the valuable partnerships that will emerge from this 65th National Symposium, 2024. Together, we can build a sustainable and prosperous future for the livestock sector.

Hoping to see you at Goa!

With Regards,

Suresh Deora
Chairman
CLFMA OF INDIA

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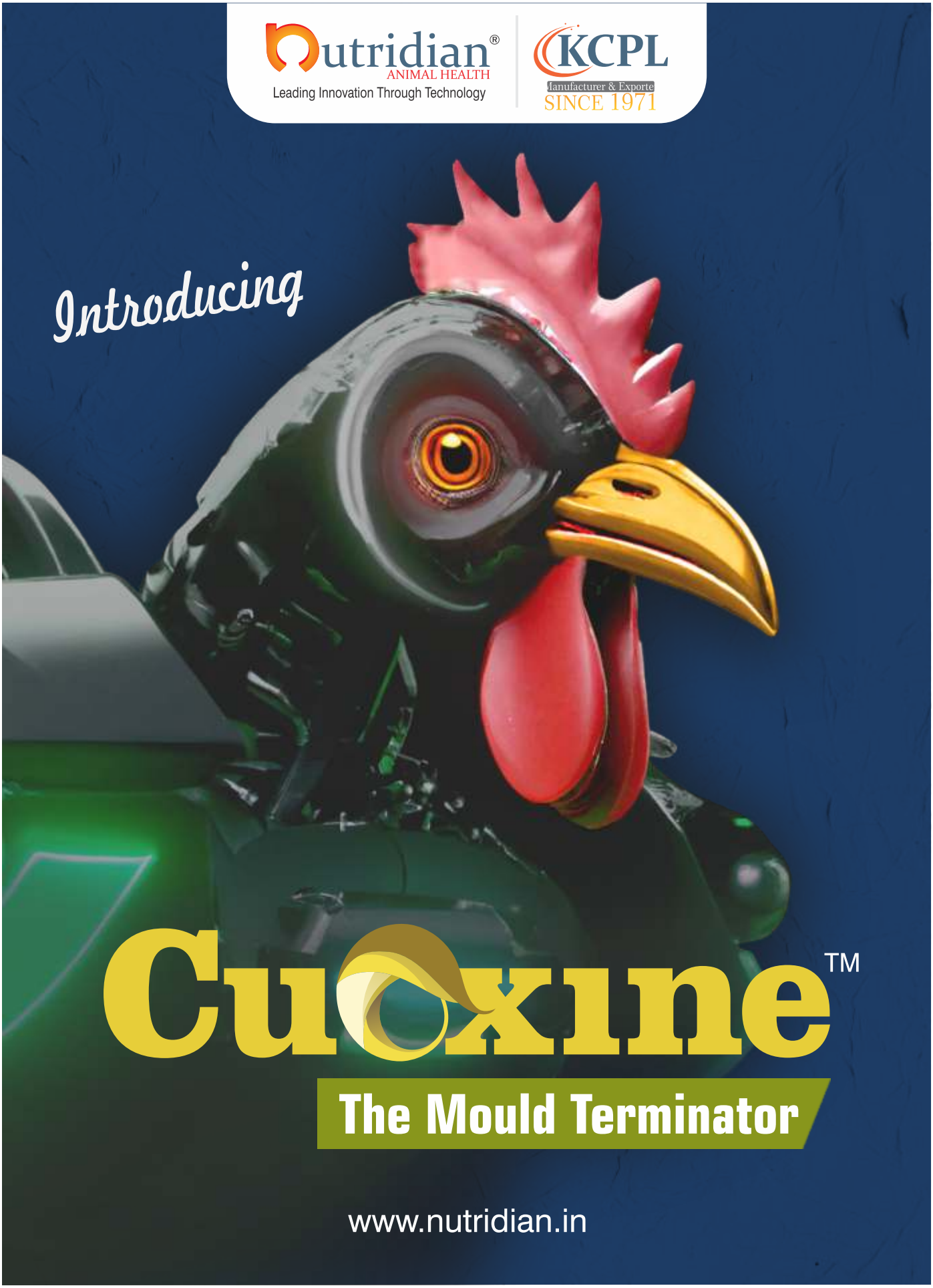

PROGRAMME

CLFMA 57th AGM & 65th National Symposium 2024

20th & 21st September 2024

Hotel Novotel Goa Resort and Spa,
Bardez, Pin 403515 Goa - India

"Sustainable Livestock Sector: Threats, Challenges and Opportunities"

Day-1: Friday, September 20, 2024

Time	Session
10:00 hrs	Registration of Delegates
11:00 hrs - 12:00 hrs	Managing Committee Meeting
12:00 hrs - 13:30 hrs	Lunch
13:30 hrs - 14:30 hrs	57th Annual General Meeting
Inaugural Session	
16:00 hrs.	**Inviting Dignitaries to the Dais inauguration & Lighting of Lamp**
16:05 hrs	**Welcome Address by Convenor** Mr. Divya Kumar Gulati, Deputy Chairman, CLFMA OF INDIA
16:10 hrs	**Chairman Address by** Mr. Suresh Deora, CLFMA OF INDIA
16:15 hrs	**Thematic Address by** Shri. Tarun Shridhar, IAS, (Retd.)
16:25 hrs	**Keynote Address by** Mr. Balram Singh Yadav, Managing Director, Godrej Agrovet Limited.
16:40 hrs	CLFMA Awards Ceremony
17:05 hrs	**Address by Guest of Honour,** Ms. Alka Upadhyaya, IAS*, Secretary AHD,
17:20 hrs	**Address by Chief Guest**, Shri. Rajiv Ranjan Singh, Hon'ble Minister of Fisheries, Animal Husbandry and Dairying
17:40 hrs	**Launching Souvenir**
17:45 hrs	**Vote of Thanks by** Mr. Abhay Shah, Honorary Secretary, CLFMA OF INDIA
19:00 hrs	**Networking Dinner & Live Performance**

Day-2: Saturday, September 21, 2024

09:30 hrs	Registration
10:00 hrs	Welcome Address by Mr. Suresh Deora, Chairman, CLFMA OF INDIA
10:05 hrs	Introduction of Symposium – Dr. Devender Hooda, CLFMA OF INDIA
10:05 hrs – 11:30 hrs	**Session 1: Managing Input Costs and Exploring Alternatives**
	Moderator: Mr. S. V. Bhave, Past Chairman, CLFMA OF INDIA
	Panelists: ·
	• Mr. Reece H. Cannady, Director, U.S. Grains Council
	• Ms. Anupa Velusamy, MD, GFFCO Global Private Limited
	• Mr. Ajay Jhunjhunwala, President, SEA of India
	• Dr. Prashant Shinde, Managing Committee Member, CLFMA OF INDIA
11:30 hrs - 11:40 hrs	Tea Break
11.45 hrs – 13.30 hrs	**Session 2: Leveraging Emerging Technologies for Efficient Livestock Management & Retailing**
	Moderator: Dr. Dinesh Bhosale, Past Chairman, CLFMA OF INDIA
	Panelists:
	• Ms. Varsha Joshi, Additional Secretary (CDD), Department of Animal Husbandry and Dairying
	• Mr. Narendra K. Pasuparthy, Founder and CEO of Nandu's Chicken
	• Mr. Nikhil Chitale, Managing Partner, Chitale Dairy
	• Mr. Balasubramaniam V, General Secretary, Prawn Farmers Federation of India
13:30 hrs – 14:30 hrs	Lunch Break
14:30 hrs – 16:00 hrs	**Session-3: Securing Sustainable Livestock: Challenges and Opportunities**
	Moderator: Mr. G. Chandrashekhar: Economist, Senior Editor and Policy Commentator
	Panelists:
	• Dr. Jiwan Kumar Gupta, Veterinary Officer, Department of Animal Husbandry, Government of Punjab
	• Mr. Suresh Rayudu Chitturi, Managing Director, Srinivasa Farms Pvt. Ltd.
	• Dr. Vibha Ahuja, Chief General Manager, Biotech Consortium India Limited,
	• Mr. Kevin Roepke, Regional Director, U.S. Soybean Export Council
	• Mr. Neeraj Kumar Srivastava, Past Chairman, CLFMA OF INDIA
16:00 hrs – 16:15 hrs	**Valedictory Session:** Summation of Symposium - **Capt. (Dr.) A.Y. Rajendra, CEO,** Godrej Agrovet Ltd.
16:15 hrs	Felicitation of Sponsors, Media, Guests, and Invitees
17:00 hrs	Vote of Thanks by Mr. Nissar F. Mohammed, Treasurer, CLFMA OF INDIA
19:00 hrs	Networking Dinner

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CALCIUM BUTYRATE COATED (30%,60% & 90%)

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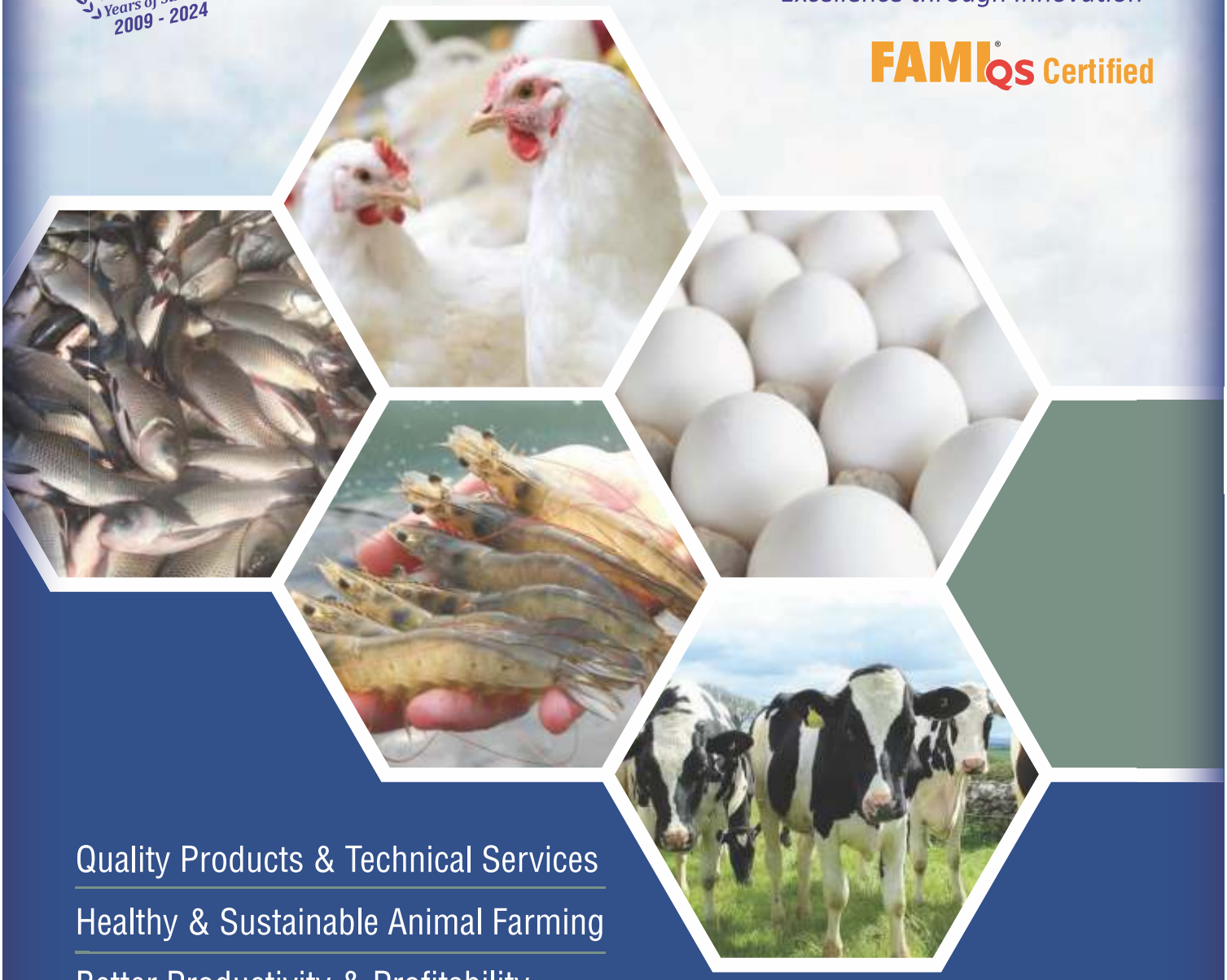

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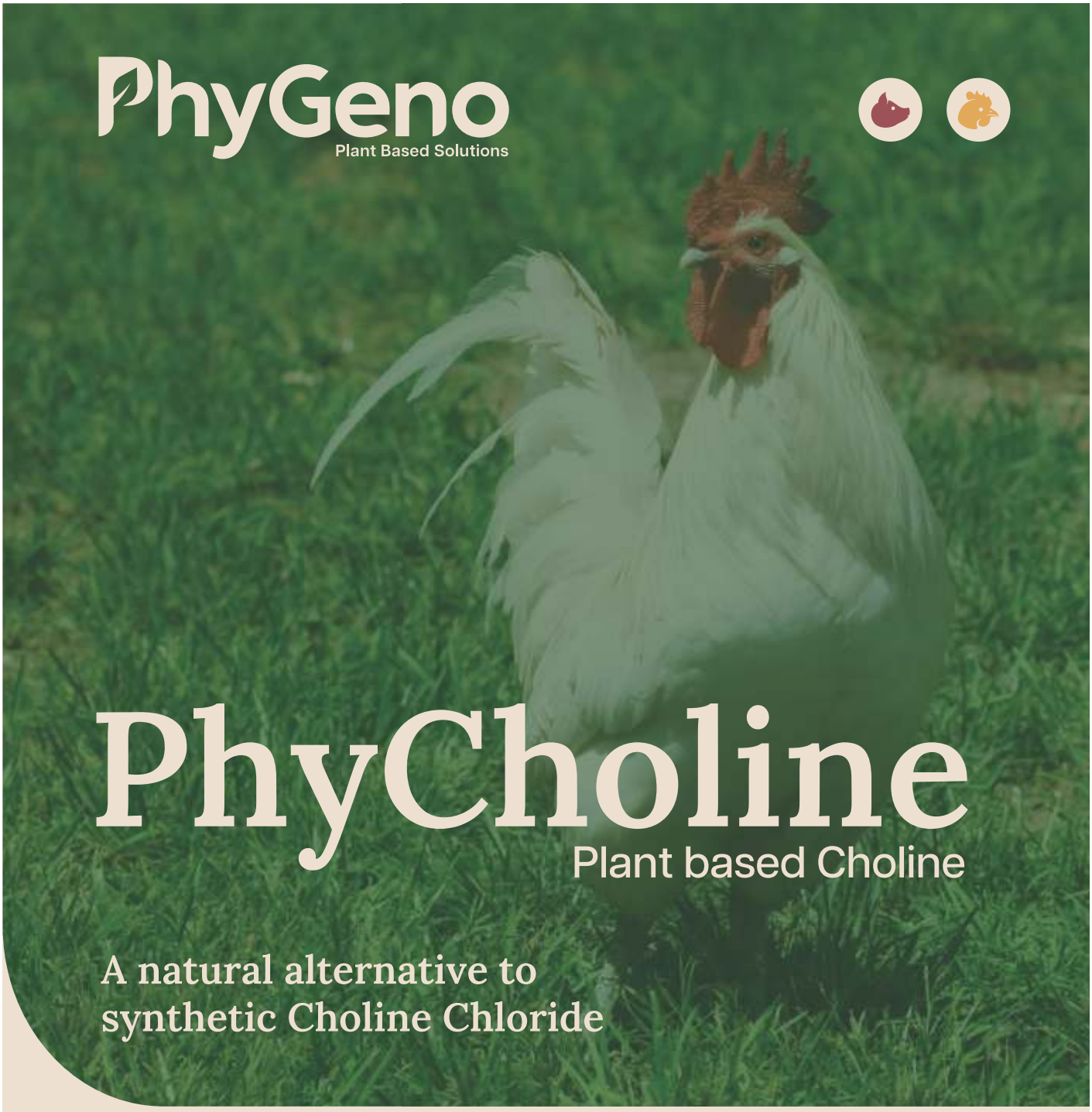

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CLFMA Lifetime Achievement Award

DR. O.P. CHAUDHARY
IFS

Dr. O.P. Chaudhary is a senior IFS officer in the Madhya Pradesh cadre with over 35 years of vast and varied experience in administration, regulation, scheme formulation, policy formulation, implementation, entrepreneurship development, training, and education.

He began his career at the district level and was subsequently promoted to various positions at the division and state levels in Madhya Pradesh. His areas of work in the state of Madhya Pradesh have mainly focused on forest management, wildlife management, biodiversity and eco-development, rural development, joint forest management, eco-tourism, indigenous peoples' participation in natural resource management, social forestry/agroforestry, plantation management, watershed management, forest produce management, and research development and extension, etc.

Dr. O.P. Chaudhary has an outstanding academic track record, having achieved academic excellence from top institutions in India and the world. He holds a B.Sc. (Gold Medalist) and M.Sc. (Physics) (Gold Medalist) from the prestigious Agra College (Agra University), an M.Tech (Environmental Engineering) from IIT Roorkee, an Executive MBA from IIM Lucknow, a PGDM (Human Rights Law) from the National Law School of India University (NLSIU), Bangalore, a Ph.D. (Finance Management) from Symbiosis International University, Pune, and has completed a Leadership Program from Harvard University, USA.

As Joint Secretary in the Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, Dr. O. P. Chaudhary was responsible for overseeing the livestock sector (including feed and fodder) in India. He not only conceptualized but also implemented the National Livestock Mission and the Animal Husbandry Infrastructure Development Fund as the National Mission Leader across the country during his tenure of over 8.5 years. He made significant contributions to the livestock sector by promoting private sector participation and entrepreneurship development. His diverse academic background, coupled with field experience, established a solid foundation for a rich government-industry interface, which is crucial for the future growth of the livestock sector. He also brought a sharp focus to research, development, new technology, and innovation. Dr. O. P. Chaudhary was instrumental in many policy and procedural reforms to ease and open the sector.

He has held various positions in the Government of India, including Regional Provident Fund

Commissioner (Ministry of Labour), Member Secretary of the Rashtriya Kamdhenu Ayog, Chairman of the Animal Welfare Board of India (a statutory body), Chairman of the Committee for Control and Supervision of Experiments on Animals (CCSEA) (a statutory body), and Vice Chancellor of Rajasthan State University.

Dr. O. P. Chaudhary has traveled extensively within India and abroad, representing the country at various forums, and has been honored multiple times for his contributions in the areas of public administration, promotion of innovation, introduction of new technologies, entrepreneurship development, and educational advancement. He has also authored numerous technical papers and scientific publications.

Currently, he is serving as the Principal Chief Conservator of Forests in the State of Madhya Pradesh.

CLFMA Award

Dr. Deepashree Narendra Desai

Dr. Deepashree Narendra Desai is Head and In-charge Professor of the Department of Poultry Science, at Mumbai Veterinary College under Maharashtra Animal & Fishery Sciences University. She has completed B. V. Sc. & A. H., M. V. Sc. and Ph. D. in Poultry Science with First Class from Bombay (Mumbai) Veterinary College and also the Post Graduate Diploma in Education Management from NMIMS, Mumbai. She has completed 22 various advance courses and trainings on Poultry Science.

She has experience of teaching and research in various capacities such as Assistant Professor for 21 years, In-charge Associate Professor for 10 years and In-charge Professor for 1.5 years and Head of Department of Poultry Science for 8 years. She has guided ten M. V. Sc. students in Poultry Science and co-guided for 26 M.V.Sc. students from other disciplines. She has seven research projects as Principal Investigator and 25 research projects as co-investigator on her credit. Currently she is guiding one Ph. D. and two M.V.Sc. students. She is also conducting Short Term Poultry Training Programs for the farmers and new entrepreneurs and so far have conducted more than 32 programs in which more than 1500 people have been trained.

Dr. Deepashree Desai has been awarded with various awards like 'Prof. G. Devegowda Poultry Science Excellence Award 2024' in recognition of significant and outstanding contributions in the field of Poultry Science on the occasion of World Veterinary Day, 'Krantijyoti Savitribai Phule Woman's Achiever's Award 2024' for outstanding individual accomplishment and distinguished veterinary services to the nation on the occasion of Republic Day of India, Best Scientific Poster Presentation Award at the National Seminar cum Workshop organized by Department of Animal Nutrition in 2023, Best Scientific Poster Presentation Award in Conference of World Veterinary Poultry Association (India) in 2023 and Best Scientific Poster Presentation Award in XXVII National Conference of Indian Poultry Science Association in 2010.

Dr. Deepashree Desai has published 38 research papers, 82 extension articles, four chapters in national and one chapter in international book and seven manuals. She has also presented 48 scientific papers in various conferences and seminars including four papers in the American Poultry Science Association Conferences in USA. She has delivered 22 radio talks and 2 television interviews in the subject of Poultry Science.

CLFMA Award

Dr. Udeybir Singh Chahal

Dr Udeybir Singh Chahal had completed his B.V.Sc.&A.H. in 1996 and M.V.Sc. (Animal Nutrition) in 1998 and Ph D (Animal Nutrition) in 2006 from CCSHAU, Hisar, Haryana. He had started his academic carrier as Assistant Professor, Animal Nutrition, at NDUA&T, Faizabad, UP and was the founder In-charge of department of Animal Nutrition. He joined Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana in 2008 as Animal Scientist. He was the founder in-charge of Regional Research and Training Centre, Kaljharani and established the various livestock units as well as fisheries and Vermi compost unit at RRTC, Kaljharani and promoted as Principal Scientist in 2015 and selected as Principal Scientist cum Head, Department of Animal Nutrition in 2021. Presently he is working as Head of the department of Animal Nutrition, GADVASU, Ludhiana. He had contributed substantially in the various extension, teaching and research activities assigned to him. A brief summary of work done is as below:

- Dr Udeybir Singh Chahal, Principal Scientist cum Head, Department of animal Nutrition, GADVASU Ludhiana has significant contribution in the field of Animal Nutrition. He is a recipient of Excellence in Teaching award, given by Samagra Vikas Welfare Society (SVWS). He had developed PG course curriculum of Animal Nutrition and was actively engaged in undergraduate as well as Postgraduate teaching and authored 5 books for undergraduate and post graduate students and contributed 5 book chapters, besides developed 17 teaching practical manuals for UG and PG students. He has also appointed as external examiner, paper setter, supervisor, invigilator and evaluator in various examinations conducted by GADVASU as well as other Universities.

- He has been bestowed with Best Extensionist award by Society of Animal and Veterinary Husbandry Extension Education. He was In-charge of Farmer's Advisory Cell and Farmer's Information Centre at GADVASU and coordinated 46 training courses on dairy, pig, goat, poultry farming and knowledge up gradation program for the farmers of Punjab and neighboring states and delivered more 300 expert lectures in various trainings. He had

coordinated/facilitated/ attended 77 Pashu Palan/Regional Kisan Melas and 23 Animal Welfare Camps, 44 exposure visits of farmers and also delivered 6 radio talks and 30 TV talks on E-TV programme.

- He has published more than 90 Research Articles (Referred journals) in national and international journals of repute and published 65 Research Abstracts in various conferences. He has been PI and Co-PI in many research projects sponsored by Govt. Agencies/ Industries. He has also been conferred with Fellow, Animal Nutrition association. He has been life member of many scientific Society/ association of Animal Nutrition and related subjects. He has represented the Animal Nutrition Society of India as CEC member, Vice President (NZ), Secretary and President of this prestigious society. During these tenures, ANSI organized International Conferences, regional workshop and many seminars in association with prestigious groups like CLFMA, AIDA, BCIL etc.

CLFMA Managing Committee has nominated and chosen you as “CLFMA Awardee” considering your excellence of service in the field of Livestock Sector and wishes you a great success in life.

Mr. Shrivardhan Vaman Bhave

Education: Graduate with a degree in Physics and Mathematics.

Address:
1st Floor, The Synergy, Plot No. 70/21, Law College Road, Pune - 411004, India.

Experience:
Mr. Shrivardhan Vaman Bhave has extensive experience in the animal feed industry, particularly in the development and supply of oils and fats (lipids). Over his 22-year career, he has been instrumental in the introduction of innovative products and technologies in this sector.

Products:
- Palm & Soya Lecithin-based Functional Fats for Feed.
- High Purity Lipids & Short Chain Triglycerides.

Professional Roles:
- Managing Director, Berg and Schmidt India Pvt. Ltd.
- Executive Director, Hightech Energy Feeds India Pvt. Ltd.

In these roles, Mr. Bhave oversees operations focused on the manufacturing and distribution of animal feed fats, specialty fats, and oleo chemicals across India, Nepal, Bangladesh, and Sri Lanka.

Key Contributions:
- Pioneered the concept of bypass fat in the Indian dairy industry in 1998.
- Introduced the latest generation nano-matrix technology for value-added fat powder in the Indian market in 2016.

Associations:
- Past Chairman, CLFMA OF INDIA.
- Associated with the Indo German Chambers of Commerce for the past 22 years.

Mr. Bhave's extensive industry experience and leadership have significantly contributed to advancements in the livestock feed sector in India and surrounding regions.

Reece Cannady
Director

Reece H. Cannady serves as the regional director for South Asia for the U.S. Grains Council, a non-profit organization that promotes the use of U.S. barley, corn, sorghum and related products worldwide.

In this capacity, he is responsible for evaluating, planning, coordinating, implementing and managing the Council's market development programs in India and the South Asia region.

Cannady previously served as the assistant director for Europe and the Middle East at the Council, in which he directed regional market development activity throughout the region. Prior to that, he acted as manager of global trade for the Council from 2018 to 2022, spending time in both the Washington, D.C., headquarters and the Tunis regional office, interacting with various global markets for U.S. coarse grains and co-products. Before his work at the Council, Cannady spent time in Amarillo, TX, working for Attebury Grain, LLC as a grain trader, selling corn, sorghum and wheat to domestic and foreign animal feeders and millers.

He graduated with a bachelor of science degree in economics with a dual concentration in finance and management from the University of Pennsylvania's Wharton School of Business.

Anupa Velusamy

Ms. Anupa Velusamy is a trailblazer in Organic Waste Management and a pioneer in Black Soldier Fly Larvae (BSFL) farming.

With a background in software engineering, she transitioned into management, honing her leadership skills across diverse industries including Retail, Machineries, IT, Textile, F&B, and Finance. Her extensive international experience and multi-industrial expertise have equipped her with the ability to adapt and excel in any business environment.

At **KovaiBSF**, she spearheads the development of sustainable alternative protein sources through BSFL farming. Her innovative approach to commercial BSFL farming has revolutionized organic waste processing, turning it into an efficient and resource-light solution.

Ms. Velusamy's work positions BSFL farming as a key technology for addressing future feedstock challenges in the animal and aqua feed industry.

Mr. Ajay Jhunjhunwala
Managing Director- J. R. Agro Industries Pvt. Ltd. and
President, The Solvent Extractors' Association of India (SEA)

Organization details: J. R. Agro Industries Private Limited, established in 1982, is a prominent name in the Indian agro-industry sector. The company is one of the leading producers of rice bran oil, specializing in the solvent extraction and refining of vegetable oils. Their products are recognized for their high quality and nutritional value.

Professional highlights: Mr. Ajay Jhunjhunwala is a distinguished industry leader and currently serves as the President of The Solvent Extractors' Association of India (SEA), a premier association for the vegetable oil industry and trade in India. With over 30 years of extensive experience in the trade, he has significantly contributed to the industry's growth. As President of SEA, he has led several trade delegations to major vegetable oil economies, including Brazil, Argentina, Malaysia, and Indonesia. His leadership reflects his commitment to promoting industry, advocating for policy improvements, and encouraging sustainable practices. With his engineering expertise, global insights, and strategic acumen, Mr. Jhunjhunwala continues to drive innovation and excellence in the agro-industrial sector. He is also a speaker at trade conferences and an invited panelist on commodities round-ups on popular TV channels like CNBC Awaaz, Zee Business, and ET Now.

Dr. Prashant Shinde

Dr. Prashant Shinde, completed BVSc in 2000 & MVSc in Animal Nutrition in 2002 both from Mumbai Veterinary College – Mumbai, completed PhD in Animal Nutrition from Indian Veterinary Research Institute in 2006. Worked as Post-doc Research fellow from 2007 till 2009 in South Korea. Has 50+ research articles published in various National & International Journal.

Joined Cargill Animal Nutrition in 2010 as Technology Application Manager in Dairy Feed, moved to Commercial role in 2014, currently working as Commercial Director for Dairy Feed & Nutrition.

Committee member of CLFMA, representing Dairy industry in formulation of BIS standards for Compound Dairy Feed.

Dr. Dinesh Tukaram Bhosale

Dr. Dinesh Tukaram Bhosale is B.V.Sc. & A.H., M.V.Sc., Ph.D. (Animal Nutrition), besides having a Diploma in Business Management. He has been a Member of Extension Council and Research Council of Rajasthan Veterinary University and Maharashtra Animal Fisheries Sciences University; Skill Advisory Board for Dairying, ASCI; BIS animal feeds committee; Editorial board of Journal of Animal Nutrition and Feed Technology; and Management Committee of ICAR - National Institute of Animal Nutrition and Physiology. He was the Chairman of CLFMA of India, an association of Indian livestock sector during 2012-2014 and was Hon' Secretary during 2008-2012. He was the Organizing Secretary of 2nd national conference of Association of Avian Health Professionals at Pune in 2014, He is working actively with Poultry Federation of India as Vice President - West India since 2006. He is also President of Vets in Private Welfare Association, Pune. He is Vice President (West Zone) of Animal Nutrition Association (2024-26).

Dinesh worked with Venkateshwara Hatcheries Ltd. in his early career and later as a Technical Director – Poultry, Aquaculture & Livestock for Asia Subcontinent office of American Soybean Association, New Delhi for eight years. Then he worked with Alltech Biotechnology Pvt. Ltd. as Regional Technical Manager – Ruminants for South Asia and Southeast Asia region for two years. He worked as Regional Commercial Director – South Asia for AB Vista, British Company from 2007 to April 2024. He is working as freelancer with companies, farmers, students and startups.

He is helping various NGOs like Paani Foundation, Swades Foundation, People Empowering Movement, Bhagirath Gramvikas Prathisthan and companies to promote Animal Husbandry as source of livelihood and as entrepreneurial activity for rural youths and Women SHGs. He is mentoring many startups in livestock sector. He delivered more than 1300 lectures to farmers and entrepreneurs all over India. He conducted Fodder Yatra to promote awareness in five states.

He may be contacted on +91 9860315558 and dtbhosale@gmail.com.

Ms. Varsha Joshi
Additional Secretary, Cattle & Dairy Development,
Ministry of Fisheries, Animal Husbandry & Dairying,
Government of India

Ms. Varsha Joshi is an IAS officer of 1995 batch, AGMUT cadre and is presently serving as Additional Secretary, Cattle & Dairy Development, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India from July 2020.

Experience

Additional Secretary, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India – from December, 2021

Joint Secretary, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India- from July, 2020

Additional charge as Chairman, National Dairy Development Board- from December 2020 - 31st May, 2021

Commissioner, North Delhi Municipal Corporation- December 2018 - July 2020

Secretary Power, Secretary Tourism, Commissioner Transport, Government of NCT Delhi- November 2016 - December 2018

Joint Secretary, Ministry of New and Renewable Energy, Government of India- October 2014 - November 2016

Director Administration & NPR, Office of Registrar General & Census Commissioner, India- September 2012 - September 2014

Director Census Operations, Delhi- November 2009 - September 2014

Consultant, United Nations Population Fund (UNFPA)- February 2014 - March 2014

Consultant, United Nations Population Fund (UNFPA)- October 2013 - October 2013

Additional Commissioner Transport, Government of NCT of Delhi, 2009 - 2009

Deputy Commissioner South West District, Government of NCT of Delhi, 2007 – 2009

Additional CEO & Director Finance, Delhi Jal Board, 2007 – 2007

Secretary to the State Government, Government of Arunachal Pradesh, 2004 – 2007

Deputy Commissioner, Lohit District, Arunachal Pradesh, 2004 - 2004

Chairperson, Committee against Sexual Harassment, Government of Chandigarh UT, 2001 – 2003

Director Public Instruction, 2000 – 2002

CEO, Chandigarh Housing Board, 1999 – 2003

Managing Director, Chandigarh Industrial and Tourism Corporation, 2000 – 2002

Sub Divisional Magistrate, Government of NCT of Delhi, 1997 – 1999

Education

Delhi University Master's degree, Physics (1991-1993)

Hindu College, Bachelor's degree, Physics (1988-1991)

Honors-Awards

UMI Commendable Initiative Award- Best NMT Project- 2019 by Urban Mobility India Conference 2019, Ministry of Housing and Urban Affairs, Government of India

President's Silver Medal for Census of India 2011 in 2013

Narendra K. Pasuparthy

Narendra Pasuparthy calls himself the 'Chief Farmer' and CEO of Nandu's chicken. He holds a Bachelors of Engineering (B.E.) from BMS College of Engineering and a Masters in Information Science and Technology from the University of Texas, Arlington.

While he hails from a business family, he chose to work outside the family business for over a decade, in order to learn how to be an employee before being an employer, and to gain an understanding of every function within an organization. He believes that this experience has culminated into his ability to build a strong organization from the ground up with a complete understanding of its end to end operations. His responsibilities with the company are varied and include Finance and Accounting, Marketing, Sales and Production and Customer satisfaction, among others.

Narendra has held several honorary and advisory roles in the industry including Honorary secretary of Bangalore Rotary Midtown. He is also on the Board of advisors for a few tech and green tech startups and is an Active Angel Investor as part of Mumbai Angels Investor Network.

He is also an avid Badminton player who took up badminton professionally during his early years in School. His other hobbies include Aeromodelling, Biking (Riders republic, Harley Owner Group (HOG)) and Music. He also enjoys Horticulture and Agriculture which then lead to the creation of several fruit orchards on the company's farms.

Narendra K. Pasuparthy is also active in contributing to society and making a difference. Through Rotary Bangalore Midtown he has participated in providing assistance to several government primary schools and the running of a pharmacy to dispense medicine free of cost. With his Mid-Town Rotarians, he has raised sizeable donations for the Akshaya Patra Mid-Day Meal Scheme and assisted in setting up Karnataka's first skin bank at Victoria Hospital in Bangalore.

On the personal front he is married to Reshma Pasuparthy and is blessed with 2 Sons, Abhay and Tanmai Pasuparthy. Both kids are following their father's footsteps with their passion for music and play acoustic and electric guitar. Both are also good swimmers and badminton players.

Nikhil Chitale

Nikhil Chitale is a fourth generation Partner at 85-Year-old Chitale Group.

He studied Mechanical Engineering at Vishwakarma Institute of Technology. After interning with Alfa Laval India for 1 year, he went to State University of New York in the United States to pursue Master of Science in Industrial & Systems Engineering. He then worked with one of the leading chocolate manufacturers in the world, Lindt Chocolates for nearly half a decade. He was in-charge of production facility which produced 300 MT of chocolate every day. He was promoted & later awarded by LINDT group for demonstrating great leadership & for displaying initiative during unforeseen circumstances. After his spell at Lindt & gaining significant practical experience in different part of the world, Nikhil then moved back to India to work with the family business.

Over the last few years, Nikhil has handled multiple roles at Chitale Group that includes manufacturing, operations, supply chain, data management and MIS, Franchising and Infrastructure Creation. Nikhil is now leading the Sales & Finance Business at Chitale Group. Chitale Group now retail through their network of 50+ stores and more than 2.5 Lakh retailers and super markets across the country and global markets.

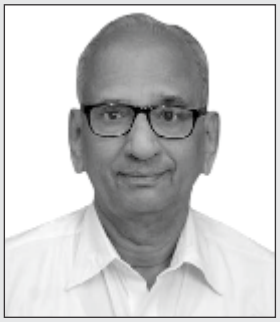
Nikhil is now focused on making Indian food healthier and Chitale Group forayed into healthy Indian foods with fortified milk, dahi & yoghurt category. The range now includes fortified milk, milk products along with soon to be launched Healthy Breakfast range.

Nikhil Chitale is an entrepreneur and the founder of BonCo Chocolates, a new and innovative chocolate brand launched under his startup. With a passion for high-quality, artisanal chocolates, Nikhil has quickly made a name for himself in the confectionery industry. BonCo Chocolates, known for its rich flavours and premium ingredients, has ambitious plans to expand across India, bringing a unique chocolate experience to a wider audience.

Nikhil is also an avid Music Lover and formally trained to play the tabla. He is also an active squash player & fan of the National Basketball Association. Nikhil also began his Angel Investor Journey in 2020 and is invested in start-ups focusing on Cloud computing, e-commerce & cosmetic AI. Nikhil is also involved in research on agriculture, animal husbandry & economic/trade policies.

Mr. Balasubramaniam V.
General Secretary
Prawn Farmers Federation of India.

Mr. Balasubramaniam V, known as Bala, is a seasoned shrimp farmer with over 30 years of experience and serves as the General Secretary of the Prawn Farmers Federation of India. With an MBA and specialized training in Shrimp Farming and Hatchery Management. Mr. Bala has been a prominent advocate for Indian prawn farming, playing a crucial role in policy decisions and the responsible introduction of P. vannamei in India. He has held significant positions in Government organisations such as MPEDA, FSSAI, and CIBA, and launched India's first shrimp QSR chain to promote domestic shrimp consumption. Mr. Bala frequently represents Indian aquaculture at national and international forums, sharing his expertise and advocating for farmers.



G. Chandrashekhar

G. Chandrashekhar is Economist, Senior Editor and Policy Commentator specializing in agribusiness and commodity markets. He provides policy inputs for the government through his personal interaction with senior policymakers, his business television appearances and writings in leading business papers.

Chadrashekhar speaks regularly at national and international forums on a range of topics including Indian macro-economy, food and nutrition security, role of technology in agriculture, agri-infrastructure, climate change, global and Indian commodities market outlook and related topics.

Chandrashekhar has held and continues to hold several public positions. Currently, he serves as an Independent Director on corporate boards and as an Independent Member of SEBI - CDAC. He is Hon. Advisor to select trade associations.

He has been a valued Resource Person for USDA (FAS-USDA, New Delhi) for well over three decades and is associated with several international institutions including World Bank, IFPRI, IGC, GPC, ICAC and more.

Associated with cultural and social activities for decades, Chandra Shekhar is a stage artiste of over 40 years' standing and a student of Indian classical music (Hindustani style).

Dr. Jiwan Kumar Gupta

Dr. Jiwan Kumar Gupta is a distinguished veterinary professional with a comprehensive background spanning over 23 years in animal husbandry, dairy farming, and veterinary sciences. He earned his Bachelor of Veterinary Science and Animal Husbandry (B.V.Sc & A.H) and Master of Veterinary Science (M.V.Sc) degrees from Punjab Agricultural University (PAU), Ludhiana, where he was recognized with several prestigious awards, including a Gold Medal from the Society of Toxicology (STOX), India, a University Merit Certificate, and a University Merit Scholarship. He further augmented his expertise with an **MBA** in Marketing Management.

Dr. Gupta's professional journey began at the esteemed GB Pant University of Agriculture and Technology, where he served as a Senior Research Fellow and Teaching Associate. He then transitioned to the role of Deputy Manager (Animal Husbandry) at Verka Milk Plant, Amritsar, where he spent five years (2001-2006) managing dairy extension programs and organizing numerous training camps,offering essential support and knowledge to communities with limited access to resources.

Since 2006, Dr. Gupta has been a dedicated Veterinary Officer with the Punjab Government, currently stationed at Patiala at the Veterinary Polytechnic, a unique institution that is the sole training center of the Animal Husbandry Department, Punjab, where Dr. Gupta oversees the education and training of more than 200 farmers, para-veterinarians, and veterinarians each month. His efforts focus on imparting practical skills and knowledge in dairy, poultry, piggery, and goatery, ensuring that participants are well-equipped to enhance their agricultural practices. In addition he has got the grass root level experience of running NDDB governed progeny testing schemes and in charge of elite male calf rearing station at Nabha(Patiala) In addition to his practical work, Dr. Gupta has contributed to the academic field with several research publications, co-authoring a book titled *Turkey Palan* (2009),Write ups in Dairy india Book and maintaining active membership in various professional organizations, including the Indian Dairy Association and the Animal Nutrition Society of India.

Dr. Gupta’s career is characterized by his commitment to advancing the Dairy sector and improving the livelihoods of rural communities through education, research, and hands-on training. His vision for the future involves continued collaboration and strategic efforts to drive meaningful changes in the Dairy sector, both within industry and farming communities.

Suresh Chitturi Rayudu
Vice Chairman & Managing Director - Srinivasa Farms

Suresh Chitturi, leads Srinivasa Farms, a dominant force in the Indian Poultry Industry. Srinivasa is recognised as one of the builders of the Indian Poultry Industry in the last 50 years. After assuming leadership, Suresh steered Srinivasa to achieve sustainably high growth through expansion and diversification. Srinivasa is involved in Chicken Breeding, Chicken & Egg Processing, Feed Manufacturing and also Soya Oil Extraction and Processing.

His work has led to the company being recognised for always doing what is best for the individual farmers, industry and the country. Adopting a farmer first philosophy, he is passionate about ensuring that the poultry industry is healthy and sustainable through adoption of latest technologies, good rearing practices and welfare of the livestock. Suresh is helping the industry to be more sustainable and responsible in its production and sourcing.

Suresh is driven by the mission of eliminating nutritional deficiencies of women and children in India. He passionately advocates poultry as a vehicle of transformation and empowerment. His work has been recognised at a global level and is engaged in advocacy for the poultry industry, internationally as Chairman of International Egg Commission (IEC). He is the first Asian to hold this position in the history of the institution.

Besides work, Suresh is active in wildlife conservation through his work with WWF and other conservation minded organizations. He is also a talented photographer and has exhibited his photographs for raising awareness and funding for conservation.

Suresh takes pride in the role he played in the two telugu states (Telangana and Andhra Pradesh) become leaders in ease of doing business, through his work in CII in various capacities. An avid reader, averaging 50 books a year, he also loves to travel and learn about different cultures and their history.

Education

Bachelor in Computer Science Engineering, R.V College of Engineering, Bangalore.
Master of Business Administration,Goizueta Business School, Emory University, USA.
The President's Programme in Leadership, Harvard Business School, USA.

Professional Affiliations & Board Memberships

President (from 2022), Chairman (2019-2022) & Vice Chairman (2017-2019), International Egg Commission (IEC), U.K. Councillor for The International Egg Commission Foundation.

Co-founder and Board Member of TiE Amaravati. VicePresident of All India Poultry Breeders Association.

Member of the CII National Council on Agriculture (2022-23).

CO-Chairman of the CII National Committee on Animal Husbandry and Dairy (2022-23).

Board of Director - Amar Raja Batteries.

Former Chairman of Confederation of Indian Industry (CII), AP State Council (for 2 terms 2014 - 2016).

Former Chair of CII - Southern Region Startepreuners Forum. Member of CII - Southern Region Council from 2016.

Dr. Vibha Ahuja
Chief General Manager
Biotech Consortium India Limited

Vibha Ahuja, Ph.D., is the Chief General Manager of Biotech Consortium India, Ltd. (BCIL), where she began her career in 1993 and is an expert on biosafety and regulatory aspects, particularly with reference to genetically modified organisms, having more than 30 years of experience in the field. She is very well versed in issues related to the Indian biosafety regulatory frameworks and has been part of the formulation and dissemination of guidelines; also served as member of expert committees. She has expertise in planning and providing support in regulatory compliance for taking forward technologies for commercialization. She is also actively engaged as a resource expert on gene edited plants in the region. Throughout her long and distinguished career, she has been actively involved in biosafety capacity building initiatives in India and throughout South Asia. She has led several capacity building activities in the area of modern biotechnology, imparting training through seminars/workshops/national and international training programs and preparing well researched publications for various stakeholders related to biosafety and biodiversity issues, etc.

Kevin Roepke
Regional Director—South Asia & Sub-Saharan Africa (USSEC)
Board of Directors, US-Bangladesh Business Council

Kevin Roepke serves as the Regional Director of South Asia & Sub-Saharan Africa (SAASSA) for the US Soybean Export Council—the international marketing arm of US Soy.

Currently based in Dubai, UAE, Roepke leads a regional team to develop, execute and deliver the vision for differentiating, elevating preference, and enabling market access to U.S. Soy for human consumption, aquaculture, and livestock feed throughout South Asia and Sub-Saharan Africa.

Prior to this role, Roepke held similar positions, both with USSEC and the US Grains Council, covering markets in Latin America, Southeast Asia, Oceana and the PRC—having been located in Mexico, Malaysia and China.

Before his work in membership driven organizations, Roepke was with Archer Daniels Midland's (ADM) oilseed processing division where he was responsible for the Western Divisional soymeal export position.

He is a graduate of Iowa State University with a degree in Public Service and Administration in Agriculture, having been honored as the 2024 Young Alumni of the Year and a 2018 recipient of the STATEment Maker award. He is also the co-founder of an app that won the American Farm Bureau 2018 AgTech Startup of the Year. He received an MBA from the Massachusetts Institute of Technology (MIT) in Cambridge, MA.

Neeraj Kumar Srivastava
MSc, MBA

Neeraj Kumar Srivastava is a seasoned business leader with a rich background in the Animal Health and Nutrition industry. Currently working as Managing Director of South Asia at NUQO and looking after regional sales, marketing, and technical teams, driving overall business strategy and product commercialization. Neeraj's career spans over three decades, marked by notable achievements and leadership roles in various organizations.

Starting his journey in 1993 with Glaxo, Neeraj built a strong foundation in both marketing and sales. He then joined PROVIMI/CARGILL and NOVUS and served almost 30 years.

Neeraj's leadership extends beyond his professional roles. He served as the Chairman of CLFMA, a prestigious association in the Livestock industry in India, from 2020 to 2022. Additionally, he holds positions on the boards of various esteemed industry associations such as CII, PFI, and AMCHAM India, showcasing his commitment to the industry's growth and development.

His academic background includes dual master's degrees: one in Master of Science in Chemistry (MSc) and another in Master of Business Administration (MBA) with a specialization in Marketing. Neeraj's continuous pursuit of knowledge is evident through his international accreditations from reputed institutes such as Melbourne Business School, the University of Colorado, and North Carolina State University.

Capt. Dr. A. Y. Rajendra
CEO, Godrej Agrovet Limited (GAVL)

Capt (Dr) A. Y. Rajendra leads the Animal Feed & Godrej Cattle Genetics businesses at Godrej Agrovet Limited (GAVL).

He has been with Godrej Agrovet Limited since 1999. Prior to his current role, in 2019, he took over as the Managing Director of ACI Godrej Agrovet Private Limited, Bangladesh ("ACI Godrej"), a Joint Venture of GAVL and Advanced Chemical Industries, Bangladesh.

Capt Rajendra has a Master's Degree in Veterinary Sciences and has served in the Indian Armed Forces, Remount & Veterinary Corps, from 1994 to 1999.

NOVEL STRATEGIES FOR POULTRY PRODUCTION THROUGH LECITHIN SUPPLEMENTATION

Dr. S.SENTHIL MURUGAN M.V.Sc., M.S., PhD., PG.Dip(OH)

Introduction

Fats and oils are often added to poultry feeds to increase the energy content of the diet, but their use depends greatly on their chemical properties and cost. Research shows that the degree of saturation and the specific lipid structures significantly affect fatty acid absorption, gastrointestinal health, performance metrics and carcass quality. Typically, sources such as crude palm oil, rice bran oil, or tallow are used to achieve the desired energy levels in poultry diets. In India, poultry feed formulators using software generally do not account the metabolizability of fat.

During digestion, fats and oils undergo enzymatic breakdown in the gastrointestinal tract (GIT), producing free fatty acids (FFAs), which are initially hydrophobic and do not blend well with the aqueous environment of the digestive system. Young birds are having poor efficiency in digesting and absorbing fats and other essential nutrients due to immature gastrointestinal tracts, less production of natural digestive enzymes and bile, composition gut microorganisms and ingested fat quality. Emulsification and micelle formation are crucial for efficient fat absorption in poultry. Bile salts are assisting in emulsifying lipids, breaking them down into smaller droplets for easier digestion by enzymes and helped to form micelles, in the small intestine.

What is Lecithin ?

Lecithin is a co-product of the vegetable oil industry and is extracted from crude oil through sequential unit operations, which include degumming, drying and cooling. It is a mixture of phospholipids, primarily composed of phosphatidylcholine, phosphatidylethanolamine and phosphatidylinositol, along with other minor components. Lecithin can be derived from several sources, including soybeans, sunflowers, corn, canola egg yolks and marine sources.

Lecithin content in different sources

Vegetable sources	Lecithin content (%)	References
Soybean oil	60.00 – 81.90	(Nguyen et al., 2014)
Rapeseed oil	41.30 – 71.30	(Tehrany et al., 2012)
Sunflower oil	38.90 – 43.10	(Szuhaj et al., 2020)
Sesame oil	0.70 – 3.00	(Cansell et al., 2017)
Palm oil	10.00	(Panpipat et al., 2015)
Flaxseed oil	4.80 – 7.80	(Cansell et al., 2017)
Rice bran oil	33.00 – 33.60	(Sun et al., 2020)
Oats oil	5.00 – 26.00	(Arendt et al., 2013)
Corn oil	57.50 – 68.10	(Liu et al., 2018)

Types of Lecithin :

1. **Crude Lecithin:** A by-product of oil extraction processes, typically from soybeans.

2. **Refined Lecithin:** Further crude lecithin are processed to remove non-phospholipids components, resulting in higher purity and improved functionality. The different type of refined lecithins are:

   a) Lysolecithins: Enzymatic hydroxylation of crude lecithin by phospholipase-A2.

   b) De-oiled Lecithin: Physical fractionation removes triacylglycerols (TAG) and FFAs, obtaining a uniform, pure product.

3. **Modified Lecithin:** Chemically or enzymatically altered to enhance specific properties, such as hydroxylated, acetylated, or hydrogenated lecithins.

Composition of lecithin

The composition of phospholipids and fatty acids of different lecithins fron vegetable oil source are presented.

Composition	Lecithin source		
Phospholipids (%)	**Soy**	**Sunflower**	**Rapeseed**
Phosphatidyl -choline (PC)	15	16	17
Phosphatidylethanolamine (PE)	11	8	9
Phosphatidylinositol (PI)	10	14	10
Phosphatidic acid (PA)	4	3	4
Fatty acids (%)			
16:0	16	11	7
18:0	4	4	1
18:1	17	18	56
18:2	55	63	25
18:3	7	0	6

Functions of Lecithin:

1. Lecithin as emulsifier and quality:

Emulsifying agents (also known as surfactants) are a class of substances that enable the homogeneous dispersion of water in oil or oil in water as an emulsion. When two immiscible liquids, such as water and oil, are mixed, it is called an emulsion. When an emulsifying agent (emulgents or emulsifiers) is added to the emulsion, it breaks down the oil into smaller pieces that can then be dispersed evenly throughout the water. Emulsifiers are required to break down the fat droplets into smaller particle so that lipase can act on triglycerides easily and efficiently. Lipase cannot be effective on large lipid droplets. So we need emulsification of fat prior to its digestion, which means we made fat water soluble which is otherwise insoluble in water. To make fat soluble in water emulsifiers are needed.

Qualities of emulsifiers:

The fat digestion in the digestive system is based on efficiency of emulsifiers which determined by micelle formation. The micelles is simple spherical molecule and shell of this sphere is made of hydrophilic (water loving) polar groups like phosphate, choline or ethanolamine etc. and inner part is made of hydrophobic (water repelling) molecules mainly fatty acid chains. Inside these micelles fat molecules resides which will

undergoes subsequent absorption. The qualities of emulsifiers are determined by

a) Critical micelle concentration (CMC)

CMC is the concentration of surfactants at which micelles spontaneously form in a liquid. At low concentrations, surfactant molecules arrange on the surface of a liquid, decreasing the surface tension. When the surface becomes saturated, adding more surfactant molecules leads to the formation of micelles. The size of micelle is important factor in the digestion therefore, it had been identified previously that the CMC value have marked influence on the size of the micelle, lower CMC value leads to smaller micelle. CMC value is defined as the number of emulsifier molecules required to make emulsion droplet or micelle.

b) Hydrophilic-Lipophilic balance (HLB)

Molecules that possess both hydrophilic-lipophilic balance (HLB), that is, water and lipid solubility balance, are deciding factor of emulsifier's quality. It means HLB value should be more than 8 on the scale of 0 to 20. Normal lecithin based phospholipids provides HLB value of 5 which is not sufficient to be a good emulsifier but proper addition of lyso lecithin increases its HLB value up to needed level. Ratio of lecithin and lyso lecithin is important in determining the stability of micelles and hence its absorption. Lyso lecithin is derivative of lecithin and obtained by enzymatic digestion of lecithin through enzyme phospholipase A_1.

Effects of Lecithin in Poultry diets

In early chick nutrition, lecithins are crucial for improving lipid digestion and absorption, which boosts the assimilation of essential fatty acids and fat-soluble vitamins. They enhance the utilization of nutrients, protein, and carbohydrates. Choline, a component of lecithin, supports brain development and cognitive function. Lecithins also have antioxidant properties, reducing oxidative stress and the risk of infections. They facilitate the absorption of vitamins necessary for bone growth, vision, and immune health.Incorporating de-oiled soy lecithin into the diet enhances nutrient digestibility and intestinal health, leading to better overall performance. Lecithin supplementation also improves energy value and supports various biochemical and physiological functions. Emulsifiers further boost nutrient digestibility and metabolizable energy availability, improving feed efficiency and productivity. They help lower blood LDL levels, promote body weight gain, and enhance fat and dry matter digestibility while reducing serum cholesterol. Additionally, lecithins increase the concentration of polyunsaturated fatty acids (PUFAs), improve cooking yield, and enhance both the sensory quality and meat yield.

Inclusion level of Lecithin products

Research shows that lysolecithin enhances broiler performance more effectively than lecithin when included in poultry diets. The optimal inclusion levels for lysolecithin depend on the oil's quality and quantity used in the diet. Typically, lecithin is recommended at 1-2%, while lysolecithin should be used at 200-300 ppm for similar results. Nutritionists often choose the most cost-effective oil as an energy source and add lysolecithin to support lipid metabolism.

Conclusion

Synthetic emulsifiers can enhance feed efficiency, lipid absorption, and growth performance while also modifying blood lipids. However, their impact on carcass traits and overall growth performance is relatively minor. The India Poultry Meat Market, valued at approximately $6.31 billion USD in 2024, is projected to reach $7.30 billion USD by 2029, reflecting a CAGR of 2.97% over the forecast period. With a rising preference for high-protein, low-fat broiler meat, the quality of oil sources and emulsifiers used in feed is increasingly critical in the feed formulation.

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METHANE MITIGATION: A LIVESTOCK'S PATH TO SUSTAINABILITY

Yamini Khatri* and Rahul Singh Chandel

Introduction

In recent years, growing attention has been directed toward the greenhouse effect and its role in global warming. The primary greenhouse gases (GHGs) contributing to this phenomenon are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These gases act like a blanket around the Earth, trapping heat by absorbing energy and delaying its escape back into space. This process leads to a gradual increase in global temperatures, threatens livestock production. This climate change-induced stress impacts feed crop and forage quality, water availability, milk yield, animal health, reproduction, and overall biodiversity (Rojas-Downing et al., 2017). To cap global warming at 1.5°C above pre-industrial levels by 2050 as outlined by the IPCC (2018), global net-zero emissions are essential, coupled with drastic cuts in methane emissions (Rogelj and Lamboll, 2024). Methane stands out as a particularly potent contributor. It absorbs more heat per molecule than CO_2 and has a global warming potential (GWP) 28 times higher over a century. Additionally, methane indirectly contributes to global warming as a precursor to ozone, another harmful GHG (Kataria, 2015). The rising levels of atmospheric methane are closely tied to human activities, such as agriculture and fossil fuel production, with anthropogenic sources accounting for about two-thirds of total emissions. Ruminant digestion and manure management combined contribute over 32% to total human-caused methane emissions globally (FAO, 2022).

Enteric fermentation in livestock, paddy rice cultivation, and the management of animal waste collectively account for approximately 40% of methane emissions originating from agricultural activities. (Patra, 2012; Gerber et al., 2013). Addressing methane emissions is crucial in mitigating the impact of climate change and protecting the planet's future. Ruminant livestock are a primary source of human-induced methane emissions (Patra, 2014). In addition to environmental concerns, methane production represents a significant energy loss for ruminants, ranging from upto 12% of gross energy. Reducing greenhouse gas emissions from ruminant production is a formidable challenge due to the anticipated growth in demand for meat and dairy products and the limited technological solutions currently available to farmers (Beauchemin et al., 2020). Reducing methane emissions is widely recognized as the most effective short-term strategy to combat global warming due to methane's relatively short atmospheric lifespan (European Commission, 2021; Global Methane Initiative, 2021). While it's technically feasible to significantly reduce enteric methane production, doing so may increase feed costs and negatively impact the profitability of ruminant production. Consequently, this article aims to investigate various strategies for substantially inhibiting methane formation in the rumen.

Methanogenesis

The rumen is a complex ecosystem teeming with microorganisms, including bacteria (10^{10}-10^{11} cells/ml), ciliate protozoa (10^{4}-10^{6} cells/ml), methanogenic archaea (10^{6}-10^{8} cells/ml), and fungi (10^{3}-10^{6} cells/ml) (Matthews et al., 2019). The rumen's unique environment, characterized by rapid content turnover and abundant hydrogen and carbon dioxide, fosters a distinct archaeal community unlike those found in other oxygen-deprived habitats. Methane is produced within the rumen by methanogenic archaea, which consume these hydrogen and carbon dioxide generated by other rumen microbes during feed fermentation.

This process helps maintain a suitable environment for the overall rumen microbial community (Patra et al., 2017).

Methanogens are primarily categorized into three types based on their energy source: hydrogenotrophic (utilizing hydrogen and carbon dioxide), acetoclastic (consuming acetate), and methylotrophic (using methyl compounds). These methanogens are predominantly found in environments rich in their respective substrates (Lyu et al., 2018). Methanogens primarily responsible for methane production in the gastrointestinal tract, including the rumen, are hydrogenotrophic (Liu and Whitman, 2008). While methylotrophic methanogens, which utilize methylated compounds for methane production, are more prevalent in marine and sulfate-rich environments, some species (e.g., Methanosphaera, Methanosarcina, and members of the Methanomassiliicoccaceae) have been identified in the rumen, though their abundance is relatively low and influenced by diet. Acetoclastic methanogens, such as Methanosarcina and Methanosaeta, convert acetate into methane and carbon dioxide (Conrad, 2020). Methyl-coenzyme M reductase (Mcr) is the key enzyme responsible for the final stage of methane production in all methanogens. This enzyme catalyzes a three-step process shared by all types of methanogens (Kurth et al., 2020). Methanogenesis serves as the primary mechanism for removing hydrogen from the rumen, ensuring the ongoing fermentation process. This highlights the importance of targeting rumen methanogens as a key strategy for reducing methane emissions (Poulsen et al., 2013).

Strategies to reduce methane

Several methods exist to reduce methane emissions from ruminants, primarily focusing on dietary adjustments and modifying rumen conditions. **Table 1** outlines the mechanisms by which different additives reduce methane production.

Table 1: Various feed additives and their different mode of action (Palangi *et al.*, 2022)

1.	Ionophores	Monensin, Lasalocid	Increase propionate, H_2 sink
2.	Organic Acids	Fumerate, Malate	H_2 sink
3.	Plant Extracts	Tannin, Saponin, Essential oil	Decrease protozoa and archea, H_2 sink
4.	Dietary Lipids	Vegetable oil, Sunflower oil, Linseed oil	Decrease protozoa, H_2 sink
5.	Halogenated compounds	Bromochloroethane, Chloroform	Archea inhibition
6.	Electron Acceptors	Nitrates, Sulphates	H_2 sink
7.	Inorganic compounds	Nitroxy compounds	Archea inhibition
8.	Probiotics	Hydrogen utilizing bacteria	Increase propionate, H_2 sink

Dietary Manipulation

The amount of feed consumed by a cow is the main factor influencing methane production, as it directly affects the rumen's ability to generate methane (Niu et al., 2018). However, the type and quality of feed also play a crucial role by shaping the microbial population and determining how hydrogen is utilized in the rumen.

1. Forage-to-Concentrate Ratio

Reducing the proportion of forage in a cow's diet can lead to lower methane emissions. This change in feed composition alters the balance of volatile fatty acids (VFAs) produced in the rumen. Forages, rich in fiber, promote the production of acetate and butyrate, which are associated with higher methane production. In contrast, concentrates, high in

starch, increase propionate production. Propionate acts as an alternative hydrogen sink, competing with methane formation for available hydrogen (Ungerfeld, 2020). Furthermore, propionate provides more energy for the cow compared to methane. Additionally, the lower pH environment created by starch consumption can inhibit methanogens and reduce fiber digestion, further limiting methane production (McAllister and Newbold, 2008). Essentially, by increasing the proportion of concentrates in the diet, we can shift the rumen environment towards conditions less favorable for methane production. While reducing the amount of forage in a cow's diet can lower methane emissions, this approach has limitations. Increasing the proportion of grains in the diet, a common practice in intensive farming systems, can lead to health problems like laminitis, reduced milk fat content, and acidosis (Fouts et al., 2022).

2. Forage Quality

Forage quality is crucial for reducing methane emissions. High-quality forage is more digestible, providing more energy to the animal and potentially lowering methane production per unit of energy intake (Hristov et al., 2013). As forage matures, its digestibility decreases due to increased lignin content, which makes it harder for the cow to break down. This lower quality forage requires the cow to eat more to meet its nutritional needs, but physical limitations on feed intake prevent this. Consequently, cows consuming low-quality forage produce more methane relative to their milk or meat output (Jung and Allen, 1995).

3. Lipids

Including fat in a cow's diet can significantly alter how its digestive system operates. By providing a different energy source, fat changes the microbial environment in the rumen, leading to a decrease in methane production (Boadi et al., 2004). Additionally, lipids can change the microbial environment in the rumen, favoring the production of propionate (a fatty acid) over methane. This shift in microbial activity and reduced fiber digestion contributes to lower methane emissions (Honan et al., 2021; Yanza et al., 2021). Adding fat to a cow's diet can reduce methane production in several ways:

- By decreasing fiber digestion, especially of long-chain fatty acids.
- By reducing overall feed intake if fat levels exceed 6-7% of the diet.
- By decreasing the population of methane-producing microbes (methanogens).
- By reducing the number of protozoa in the rumen.
- By increasing the process of biohydrogenation.

Rumen Manipulation

Rumen manipulation is a strategy used to mitigate methane emissions in ruminant livestock by altering the microbial ecosystem within the rumen. This approach aims to reduce the production of methane, by targeting the methanogens (methane-producing archaea) and optimizing the fermentation process. Here are some key methods and strategies for rumen manipulation to achieve methane mitigation:

1. Direct inhibition

Directly preventing methane formation in a cow's stomach is a promising approach to reduce greenhouse gas emissions. However, this method might unintentionally increase hydrogen production, which could potentially harm the cow's digestion. While some studies haven't found this to be a problem, more research is needed. Scientists are exploring substances like 3-nitrooxypropanol (3-NOP) and seaweed to potentially counter these effects and reduce methane production (Almeida et al., 2021; Ungerfeld et al., 2022).

The compound 3-NOP effectively reduces methane emissions in cows without negatively impacting milk production. This substance works by interfering with a key enzyme called methylcoenzyme M reductase (Mcr), which is essential for producing methane (Duin et al., 2016; Kim et al., 2020). Seaweed, or macroalgae, is a potential source of methane-reducing compounds. These marine plants contain a mix of nutrients like amino acids, minerals, and carbohydrates. While some types of seaweed have substances that can slightly reduce methane, others contain higher levels of compounds like bromoform. Bromoform is particularly effective at inhibiting methane

production by targeting a specific enzyme involved in the final step of the methane formation process (Abbott et al., 2020).

2. Indirect inhibition

Altering the rumen environment to create less favorable conditions for methane-producing microbes is another approach to reducing methane emissions. This can involve providing alternative hydrogen sink or inhibiting the growth of microorganisms that support methanogens including archea and protozoa. Compounds like nitrate, essential oils, and tannins can influence the rumen environment in this way.

Nitrate can serve as an alternative electron acceptor to methane in the rumen. When added to the rumen, nitrate is converted into nitrite and then into ammonia, consuming hydrogen in the process. This conversion of nitrate to ammonia is energetically more favorable than the production of methane, making it a more attractive option for rumen microbes in terms of energy yield (Ungerfeld and Kohn, 2006). One major concern with nitrate is the risk of its toxicity, which occurs when nitrate is converted to nitrite. Nitrite can prevent oxygen from being transported effectively in the blood, potentially leading to serious health issues (Lee and Beauchemin, 2014). Managing this risk is difficult, especially in large-scale operations. Additionally, nitrate can increase hydrogen emissions, resulting in energy loss for the animal. To mitigate these problems, gradual introduction of nitrate and the use of encapsulated nitrate can help reduce the risk of nitrite toxicity and excessive hydrogen production (Almeida et al., 2021). Essential oils are composed of volatile, lipid-based compounds. Their mechanism for reducing methane production is not fully understood, but it's believed they interfere with microbial activity by disrupting cell membranes. Additionally, some essential oils may increase propionate levels in the rumen, reducing the amount of hydrogen available for methane production (Ugbogu et al., 2019).

Tannins are a diverse group of plant-based compounds that have shown promise in reducing methane emissions from ruminant animals like cows. However, their effectiveness comes with some challenges. There are two main types of tannins: hydrolysable and condensed. Hydrolysable tannins directly inhibit methanogens, but unfortunately, they can also be toxic to ruminants (Goel and Makkar, 2012). Therefore, condensed tannins are the focus of most research on methane reduction. Examples of condensed tannins being studied include Leucaena leucocephala forage, and Acacia mearnsii extract etc (Alves et al., 2017; Denninger et al., 2020). These tannins may reduce methane production in several ways:

- **Binding:** They can bind to proteins, carbohydrates, and microbial enzymes, potentially hindering their function.
- **Alternative Hydrogen Sink:** They might offer an alternative pathway for hydrogen utilization, diverting it away from methane production.
- **Disrupting Hydrogen Transfer:** Tannins could interrupt the exchange of hydrogen between different microbial populations within the rumen (Naumann et al., 2017; Ku-Vera et al., 2020).

Conclusion

To significantly reduce global methane emissions from livestock, it is essential to substantially decrease methane production per animal, given the anticipated growth in global livestock populations. Animal nutritionists aim to minimize energy loss in animal feed while reducing methane and carbon dioxide emissions without compromising animal health, productivity, or product quality. Implementing strategies to mitigate methane can inadvertently impact rumen microbial populations and fermentation, potentially affecting animal breeding. Therefore, considering economic factors, the relationship between greenhouse gas emissions and animal productivity, feed processing methods, and farm management practices is crucial. While various strategies can effectively reduce methane, a balanced approach is necessary to optimize overall system sustainability.

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LIVESTOCK DISEASE CONTROL PROGRAMS IN INDIA FOR SUSTAINABLE MILK PRODUCTION

Prof .R.N. Sreenivas Gowda*

Introduction

Livestock sector is a key subsector of the Indian agriculture. India has a vast resource of livestock and poultry, which plays a vital role in improving the socio-economic conditions of rural masses. There is a saying in our country that "Agriculture is back bone of Indian economy, Farmer is the backbone of Agriculture and livestock is the backbone of the farmer". Therefore, livestock farming is an integral part of Indian agriculture. It is likely to be the instrument of future growth and development of this sector. The country currently hosts ~536 million livestock and is the world's largest producer of milk with 187.7 million tonnes per year with an annual growth of 6.5% (Annual Report 2018-19, NDDB). Significant increase in milk production popularly known as "White Revolution' has provided income security to the dairy farmers and ensured milk availability to a great majority of the population, thereby supplementing the efforts towards nutritional security in the country. A third dimension of livestock farming is supply of cow dung for enriching soil health, thereby enhancing and sustaining crop productivity. Proper management of the huge livestock resources the country is essential to derive the targeted benefits from them. In this direction NBAGR/ ICAR has already identified and registered 199 livestock breeds, which are being conserved and further improved. As per National statistics-2019, GOI Animal Husbandry, Dairying and Fisheries department, 20.5 million people depend on Livestock sector activities for their livelihood. It also provides employment about 8.8 million people in India. This sector contributes 4.11% to GDP and 25.6% to total Agriculture GDP.

Livestock Population in India

India has a vast resource of livestock and poultry, which plays a vital role in improving the socio-economic conditions of rural farmers. India possesses ~536 million livestock population, which includes 192.49 million cattle, 109.85 million buffaloes, 148.9 million goats, 74.3 million sheep and 9.1 million pigs, and poultry population of 851.8 million (Table.1).

Table.1. The Indian Livestock Population and world ranking (2019 National Survey)

	Livestock	No in millions	Global ranking
1	Buffalos	109.85	No one
2	Cattle	192.49	No. one
3	Yak	0.1	No. one
4	Mithun	0.4	No. one
5	Sheep	74,3	No, two
6	Goat	148.9	No. two
7	Pigs	9.1	No. seven
8	Horse &Ponies	0.3	Of >58 Million in the world
9	Camel	0.3	No Nine
10	Mules &Donkeys	0.2	Of >5o million in the world
11	Poultry including ducks and others	851.8	No. four

All though India is ranking number one in livestock population, yet we are in 12th place asper Livestock production index-2018. India holds about 16.5 % Dairy cows, highest in the world but produces only 15 MMT milk compared to a developing country like USA, having only 3.4 % of Dairy cows producing 87 MMT milk. In this way India is not even top 20 countries as per average milk production per cow and much behind global average 2200 liters per cow per year. In India the average milk yield (2018) per exotic cross breed cow is 7.71 kg /day, Indigenous non descriptive cow produce 2,93 kg/day and buffalo produce 5,47kg/ day and Goat produce 0.47 kgs /day.

Challenges faced by livestock sector

There are many challenges the sector will come across, during the process of achieving any set target in the future, like disease outbreaks, antimicrobial resistance, greenhouse gas emission, inadequate human resources and infrastructure for veterinary services, low productivity of animals, non-remunerative milk prices.

Other major challenges faced by the sector are inadequate availability of credit, poor access to organized markets, limited availability of quality breeding bulls, water sources depletion, deficiency of vaccines and vaccination set-up, diversion of feed and fodder ingredients for industrial use.

Constraints and challenges of dairy sector

The major constraints the dairy sector is currently facing include:

1. Large population of non-descript cattle and buffalos with low production;
2. Huge gap between requirement and availability of feed and fodder;
3. Adverse impact of climate change, drought and heat on milk production and quality;
4. Infectious and non-infectious diseases, nutritional deficiencies and metabolic diseases: poor animal health, frequent outbreaks of transboundary diseases;
5. Shortage of vaccines and diagnostics, and large number of diseases being transmitted from animals to human (zoonotic diseases);
6. Infertility/sub-fertility, silent-heat and reproductive diseases and disorders in dairy animals;
7. Late sexual maturity of both male and female bovines;
8. Limited availability of high quality male germplasm (breeding bulls, as well as frozen quality semen, sexed embryos/semen);
9. Increasing infertility among crossbred animals;
10. Inadequate public institution support
11. Low processing and value-addition of milk; and inadequate value-chains and marketing.
12. Inadequate attention towards extension services
13. Judicial use of antibiotics to reduce antibiotic resistance

Disease Challenges and suggested interventions

Livestock productivity is adversely affected by various animal diseases, some of them being zoonotic in nature. Occurrence of diseases causes heavy economic loss in terms of livestock health vis-a-vis production and has serious impact on export of livestock products including germplasm.

Around 80 percent of the listed animal diseases are prevailing in India (OIE/ WOAH). The outbreaks of Foot-and-Mouth disease, Brucellosis, Infectious Bovine Rhinotracheitis (IBR) and Haemorrhagic septicemia(HS) in cattle and buffaloes and recent outbreak of Lumpy Skin Disease(LSD),PPR, goat pox, sheep pox, and orf in goats and sheep, classical swine fever in pigs, Newcastle disease, infectious bursal disease and highly pathogenic Avian influenza in poultry have underlined the adverse impact of these diseases on livestock and poultry productivity.

Currently available facilities:

India is having a network of 27,562 Polyclinics / Hospitals / Dispensaries and 25,195 Veterinary Aid Centers (including Stockmen Centers and Mobile Dispensaries), which are supported by about 250 disease diagnostic laboratories. And about 70 veterinary colleges, 26 veterinary vaccine

production units. (Of these, 19 are in the public sector and 7 are in the private sector). Producing the vaccines against important livestock and poultry diseases in the country. Currently these institutions are dealing with any disease situations and need to be strengthened.

National schemes aimed for growth of livestock sector in India

The overall aim of the Livestock Health & Disease Control scheme is to improve the animal health sector by way of implementation of prophylactic vaccination programmes against various diseases of livestock and poultry, capacity building, disease surveillance and strengthening of veterinary infrastructure.

Developmental programs like **National Livestock Mission** to enhance the nutritional levels and standard of living in livestock farmers, **National programme for Dairy Development** to increase quality of milk and milk products, **Rashtriya Gokul Mission (RGM)** for encouraging farmers to rear indigenous breeds. Disease control programs as **National Animal Disease Reporting System (NADRS)** for reporting of animal disease, Scheme of livestock health and disease control (LH and DC) provide financial assistance for control of animal diseases and **National Disease Control Program for Foot and Mouth Disease (FMD) and Brucellosis (NADCP)** to keep control on FMD and Brucellosis and try to eradicate them by 2030 through vaccination. Program has received 100 percent funding. Some of the Infrastructural development funds like Animal Husbandry Infrastructure Development Fund with corpus of Rs. 15000 crore for investment to companies, farmers, etc. to establish meat and dairy processing and Animal Feed Plant. Dairy Processing and infrastructure Development Fund with corpus Rs. 8004 crore to provide loan to modernize the milk processing plants.

Livestock health and disease Control Programme of India

The Livestock Health and Diseases Control (LH&DC) scheme is a Centrally Sponsored Scheme (CSS) implemented by the Department of Animal Husbandry and Dairying (DAHD), Ministry of Agriculture and Farmers' Welfare, Government of India.

The Scheme now has nine components as under:

(I) Assistance to States for Control of Animal Diseases (ASCAD)

(ii) National Project on Rinderpest Surveillance and monitoring (NPRSM)

(iii) Professional Efficiency Development (PED)

(iv) Foot and Mouth Disease Control Programme (FMD-CP)

(v) National Animal Disease Reporting System (NADRS)

(vi) Peste des Petits Ruminants Control Programme (PPR-CP)

(vii) Establishment & Strengthening of Existing Veterinary Hospitals and Dispensaries (ESVHD)

(viii) Brucellosis Control Programme (Brucellosis-CP)

(ix) Classical Swine Fever Control Programme (CSF-CP)

Sustainable milk production

As far as sustainability is concerned, the best practices circumvent the following pivot points:

- Consider the farm's structure & local situation before choosing bovine breeds
- Keep the farm free from disease by having an effective herd disease health management practice in place.
- Use certified and prescribed chemicals and veterinary medicines to prevent the occurrence of chemical residues in milk.
- Carry out milking activities under hygienic conditions to ensure that milking routines do not injure cows or contaminate milk.
- Feed and water all animals in sufficient quantity, and with products of suitable quality and safety.
- Control feed storage conditions
- Ensure traceability of feedstuffs brought off the farm.
- Keep all animals free from hunger, thirst,

malnutrition, discomfort, pain, injury, disease, fear, and distress.

Mitigation of challenges

- Adoption of sex-sorted semen technology,
- By-product manufacturing and utilization,
- Use of feed supplements,
- Replacement of low producing animals with the high producers,
- Judicious use of antibiotics,
- Promotion to organized market, livestock-based integrated farming system
- Public-private partnership, and separate cadre for livestock extension

Conclusion

Livestock is an integral part of agriculture, and it plays a significant role in the Indian economy and nutritional security of the people. The sector provides livelihood to more than two-thirds of the rural population. India has the largest animal husbandry sector in the world and contributes 18.6 percent only to the total milk production of the world. There are many challenges the sector will come across during the process of achieving any set target in the future like disease outbreaks, antimicrobial resistance, and greenhouse gas emission, inadequate human resources and infrastructure for veterinary services, low productivity of animals, non-remunerative milk prices, the unorganized markets for livestock products, low animal productivity, poor livestock extension, and shortage of feed and fodder. The adoption of sex-sorted semen technology, by-product utilization, use of feed supplements, replacement of low producing animals with the high producers, judicious use of antibiotics, promotion to organized market, livestock-based integrated farming system, public-private partnership, and separate cadre for livestock extension are some of the suggested inventions to mitigate these challenges. Every sub-sector of the livestock has an annual growth rate of more than 5 percent, validating the enormous scope for a rainbow revolution in the sector. The livestock sector has equitable distribution, unlike agriculture, such that each scheme or policy of the government directly affects the individual household. Hence, Livestock is the new growth of the agriculture sector.

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"SUSTAINABLE LIVESTOCK SECTOR: THREATS, CHALLENGES, AND OPPORTUNITIES"

Rohini Kalyani

The livestock industry plays a vital role in global agriculture by supplying key products like meat, milk, and eggs. Despite its importance, this sector encounters obstacles to sustainability, such as environmental issues, limited resources, and socio-economic factors. Nevertheless, there are various prospects to improve the sustainability of livestock production through innovative methods, technological progress, and policy measures.

Threats to Sustainable Livestock Production

Environmental Degradation

Environmental degradation poses a major challenge to the sustainability of the livestock industry. This sector significantly contributes to greenhouse gas emissions, particularly methane and nitrous oxide, with the Food and Agriculture Organization estimating that it is responsible for around 14.5% of global emissions. These gases exacerbate climate change, negatively impacting agricultural productivity and ecosystem health.

Land degradation is another pressing concern, as overgrazing can result in soil erosion, loss of vegetation, and desertification. Such degradation diminishes land productivity and threatens biodiversity and water quality. Additionally, deforestation for pasture and feed crop production worsens these issues, leading to habitat destruction and increased carbon emissions.

Water pollution remains a critical issue linked to livestock farming, as runoff containing nutrients, antibiotics, and pathogens can contaminate water bodies. This contamination may lead to eutrophication, harmful algal blooms, and the deterioration of aquatic ecosystems.

Resource Constraints

The livestock industry relies significantly on natural resources, including water, land, and feed. As the global population grows and the demand for animal products rises, the strain on these resources becomes more pronounced. Water scarcity poses a significant challenge due to the high water requirements of livestock production.

Additionally, land availability presents a challenge, as the expansion of livestock farming often competes with other land uses like crop cultivation and urbanization. This competition can create conflicts and restrict the area available for sustainable livestock operations.

The availability of feed is intricately tied to land use and agricultural efficiency. Producing feed crops such as maize and soybeans demands considerable resources, including land, water, and energy. Furthermore, reliance on monoculture feed crops can result in soil degradation and a reduction in biodiversity.

Socio-Economic Factors

Socio-economic challenges significantly impact sustainable livestock production, particularly for smallholder farmers in many developing nations who often face limited access to essential resources, technology, and markets. This lack of support hinders their capacity to implement sustainable practices and enhance productivity.

Economic pressures frequently lead to unsustainable farming practices, as the demand for low-cost animal products encourages intensive farming that focuses on immediate profits rather

than long-term sustainability. Such practices can result in excessive antibiotic use, compromised animal welfare, and environmental harm.

The sustainability of the livestock sector is also shaped by global trade and market dynamics. Trade policies, subsidies, and market volatility can create uncertainties that affect livestock farmers' livelihoods, with trade barriers restricting market access and feed crop subsidies distorting prices, thereby promoting unsustainable practices.

Challenges in Achieving Sustainable Livestock Production:

1. **Balancing Productivity and Sustainability**
   Achieving sustainable livestock production involves balancing productivity with environmental and social sustainability to meet the growing demand for animal products and ensure food security.

   Sustainable intensification focuses on increasing productivity while minimizing negative environmental and social impacts through improved practices like animal breeding, feed management, and waste management. Implementing sustainable intensification practices can be challenging due to the required investment, technology, and knowledge.

2. **Enhancing Animal Welfare**
   Ensuring the well-being of animals is crucial for sustainable livestock production. Neglecting animal welfare can result in health issues, decreased productivity, and ethical dilemmas. This involves providing proper housing, nutrition, healthcare, and minimizing stress and suffering.

   Enhancing animal welfare in intensive farming systems can be difficult and may necessitate changes in management, infrastructure, and increased expenses.

   Nevertheless, prioritizing animal welfare is vital for ethical and sustainable livestock production.

3. **Reducing Environmental Impacts**
   Reducing the environmental impacts of livestock production is a major challenge. This involves addressing issues such as GHG emissions, land degradation, and water pollution. Various strategies can be employed, including:

   - **Improved Manure Management:** Proper handling and treatment of manure can reduce emissions and prevent water contamination.
   - **Efficient Feed Use:** Optimizing feed use and incorporating alternative feeds can reduce the environmental footprint of livestock production.
   - **Agroforestry and Silvopastoral Systems:** Integrating trees and shrubs into livestock systems can enhance carbon sequestration, improve soil health, and provide additional income sources.

   Implementing these strategies requires investment, knowledge transfer, and supportive policies. It also involves overcoming barriers such as lack of access to technology and resistance to change.

Opportunities for Sustainable Livestock Production

1. **Technological Innovations**
   The livestock sector can benefit greatly from technological innovations, with Precision Livestock Farming (PLF) being a prime example. PLF utilizes sensors, data analytics, and automation to monitor and manage livestock, leading to improved efficiency, reduced resource use, and better animal welfare through real-time information on health, behavior, and environmental conditions.

   Biotechnological advancements also show potential for sustainable livestock production, such as genetic improvement through selective breeding and genomic technologies to enhance animal productivity, disease resistance, and feed efficiency. Furthermore, progress in feed additives and alternative feeds can help minimize the environmental impact of livestock production.

2. **Integrated Livestock Systems**
   Integrated agricultural systems, including mixed crop-livestock and agroforestry systems, present sustainable production possibilities. These systems can improve resource utilization, soil health, and biodiversity. For instance, integrating livestock with crop production can offer natural fertilizer, decrease reliance on chemical inputs, and enhance crop yields.

   Agroforestry systems, which integrate trees and livestock, can offer various advantages, such as carbon sequestration, enhanced water retention, and diversified income streams. These systems can bolster the resilience of farming systems against climate change and market fluctuations.

3. **Policy and Market Incentives**
   The implementation of policies and market incentives is essential in driving sustainable livestock production forward. Governments and international organizations have the power to introduce policies that promote sustainable practices within the industry. These policies can include subsidies and incentives that provide financial support for initiatives like organic farming, improved waste management, and the use of renewable energy sources.

   Additionally, regulations and standards can be put in place to ensure animal welfare, environmental protection, and food safety are prioritized within the livestock sector. Research and development efforts are also crucial in advancing sustainable livestock technologies and practices, with support from governments and organizations being key in this area.

   Market incentives, on the other hand, can be driven by certification schemes and increasing consumer demand for sustainable products. Certifications for organic, free-range, and grass-fed animal products, for instance, can create new market opportunities for farmers while simultaneously encouraging the adoption of sustainable practices within the industry.

4. **Capacity Building and Knowledge Transfer**
   Enhancing the capabilities of farmers, especially those operating on a small scale, is crucial for achieving sustainable livestock production. This process includes offering educational opportunities, training programs, and extension services that equip farmers with the necessary skills and knowledge. Effective knowledge transfer enables farmers to embrace best practices, boost their productivity, and promote sustainability in their operations.

   The role of extension services and farmer networks is vital in spreading information and innovative techniques throughout the agricultural community. By employing collaborative strategies such as participatory research and peer-to-peer learning, farmers can be empowered to adopt sustainable practices and effectively respond to evolving environmental and market conditions.

Case Studies and Success Stories

New Zealand: Integrating Livestock and Forestry

New Zealand has successfully implemented integrated livestock and forestry systems. These systems, known as silvopastoral systems, involve the integration of trees and livestock on the same land. The benefits include improved pasture quality, enhanced biodiversity, and increased carbon sequestration. Farmers have also reported additional income from timber and non-timber forest products.

Denmark: Reducing Antibiotic Use in Livestock

Denmark has made significant progress in reducing antibiotic use in livestock production. Through a combination of regulations, monitoring, and farmer education, Denmark has achieved one of the lowest levels of antibiotic use in Europe. This has led to improved animal health, reduced antibiotic resistance, and enhanced food safety.

Brazil: Sustainable Beef Production

Brazil has developed initiatives to promote

sustainable beef production. The country's Low Carbon Agriculture Plan (ABC Plan) encourages practices such as improved pasture management, integrated crop-livestock systems, and reforestation. These practices have resulted in reduced GHG emissions, improved land use efficiency, and increased productivity.

Conclusion

Sustainable livestock production is confronted with a multitude of obstacles and difficulties, such as environmental deterioration, limited resources, and socio-economic influences. Nevertheless, there are also substantial prospects for improving sustainability through technological advancements, comprehensive systems, policy measures, and skill development.

To attain sustainable livestock production, a comprehensive strategy that takes into account environmental, social, and economic aspects is necessary. This entails implementing best practices, allocating resources for research and development, establishing supportive policies, and creating market incentives.

By addressing these challenges and capitalizing on opportunities, the livestock sector has the potential to make significant contributions to global food security, environmental sustainability, and socio-economic progress.

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SUSTAINABLE ANIMAL AGRICULTURE ECOSYSTEM NECESSARY FOR SUSTAINED GROWTH IN LIVESTOCK SECTOR

G. Chandrashekhar

The stellar contribution of the livestock sector to economic growth, employment generation as also global food and nutrition security is well recognized. In the last ten years, the sector has grown remarkably; but there are challenges ahead.

Over the next ten years, the global livestock industry will have to navigate through a maze of road bumps. Climate change and animal disease threats are two of the many challenges the sector is likely to face. The sector has to recognize the need for investment in production modernization, address labour shortages, ensure regulatory compliance and advance environmental sustainability.

At the same time, advances in productivity, largely due to improved genetics and farm management are expected to enhance breeding rates and animal slaughter weights, helping to ensure that supply keeps pace with demand, according to OECD-FAO Agricultural Outlook 2024-2033.

Productivity advances, whether intensive or extensive production regimes, will play an increasingly critical role in planning and managing meat production, ensuring sustainability and limiting the environmental impact of livestock farming.

Worldwide, growth in livestock populations will be close to 2 billion cattle, 1 billion pigs, 32 billion poultry, and nearly 3 billion sheep. Consequently, the meat industry's greenhouse gas (GHG) emissions are predicted to rise 6 percent by 2033.

This rise in emissions is smaller than the 12 percent growth in meat production, attributed to an increased proportion of poultry in the meat production mix and advances in productivity that allow for more meat to be produced per animal, with a decreasing amount of GHG emissions per unit of meat produced.

Animal disease outbreaks pose significant uncertainties for the meat sector, with economic impacts from such incidents often disrupting markets and requiring years for resolution.

This underscores the importance of collaborative biosecurity efforts to ensure the sector's sustainability, particularly in the face of risks to exports and imports. The meat industry's environmental impact, notably its substantial resource consumption and GHG emissions, will be shaped by global demand trends, productivity improvements, and environmental policy implementation.

Demographic changes, health awareness, and environmental concerns may gradually decrease meat consumption. In addition, the industry should aim to provide high-quality protein while pursuing sustainability, aligning with the United Nations Sustainable Development Goals (SDGs) through enhanced animal welfare, worker well-being, reduced packaging, and minimizing food loss and waste

In this backdrop, the global animal feed market is undergoing marked changes that are likely to accelerate in the years ahead. The pattern of global consumption is evolving towards higher share of animal products in diets. So, higher quantities of crops will be used as feed.

Maize (corn) and protein meal (oilseed extractions) will remain the most important feed commodities and will constitute 60 percent of total feed use over the next 10 years. Feed demand for maize is set to grow slightly faster than that of protein meals.

Importantly, worldwide meat consumption is shifting towards poultry, primarily reflecting lower poultry prices in low-income developing countries where demand is price elastic. As incomes recover, demand will recover too.

Over the next ten years, poultry meat will represent well over 40 percent of all protein from meat sources as consumers are attracted to lower price, product consistency and higher protein / lower fat content.

There will be challenges, though. Disease outbreaks, sanitary restrictions and trade policies may affect the evolution and dynamics of the world meat market.

Poultry scores in meeting these challenges simply because poultry can respond more quickly to market signals due to shorter production cycle as compared with ruminants.

Importantly, poultry is amenable to faster improvement in genetics, animal health and feeding practices. As poultry expands, GHG emissions will slow. Indeed, in the US, young cattle are given 'potty-training' in facilities - known as 'Moo-Loo' – in order to restrict the spread of greenhouse gases.

These trends are sure to find an echo in India, world's largest producer of milk and third largest in egg production. The annual growth rate of animal husbandry, diary and fisheries is arcing to enter double digit.

In our country, animal husbandry, dairying and fisheries are significant growth drivers. These allied sectors of Indian agriculture are steadily emerging as robust growth centres and promising sources for improving farm incomes.

From 2014-15 to 2022-23, the livestock sector grew at an impressive Compound Annual Growth Rate (CAGR) of 7.38 per cent at constant prices. The contribution of livestock to the total GVA (at constant prices) in agriculture and allied sectors increased from 24.32 per cent in 2014-15 to 30.38 per cent in 2022-23.

In 2022- 23, the livestock sector contributed 4.66 per cent of the total GVA, significantly boosting the per capita availability of milk, eggs, and meat. The fisheries sector, a crucial contributor to the Indian economy, makes up about 6.72 per cent of the agricultural GVA and has grown at compound annual rate of 8.9 per cent between 2014-15 and 2022-23 (at constant prices).

This “sunrise sector” supports approximately 30 million people, particularly marginalised and vulnerable communities, the Economic Survey 2023-24 asserts.

In this backdrop the industry must examine and evolve a sustainable animal feed market. Such a market will have to be part of 'Sustainable Animal Agriculture Ecosystem'. The industry has inherited a legacy ecosystem that does not recognize sustainability and needs to evolve to face looming changes. For the purpose, review of technologies, services, standards and regulations is necessary.

For the animal feed manufacturers, there are challenges to overcome in sourcing raw material for feed including land constraint, water shortage, climate change, low crop yields, lack of tech infusion and but not the least, policy constraint.

Stakeholders in animal agriculture face challenges. Uncertainty of raw material / feed availability, feed price volatility, demand fluctuation, policy environment and gradual inroads made by plant protein are some of the issues the industry will have to tackle.

Of course, there are solutions the industry must be ready to embrace. For assured availability and access to raw material, contract farming is the way forward. Establishing backward linkages especially with FPOs (Farmer Producer Organizations) will provide price stability and assured access with scale economies.

Feed price volatility often hurts the bottom line of manufacturers. Hedging in commodity exchanges through the derivatives route is a time-tested method of price risk management. Delivery based Forward contracts can be explored.

While pervasive protein deficiency in India is sure to boost protein consumption as incomes rise, perhaps the biggest challenge to animal protein will come from the rapidly emerging plant protein segment. The industry must recognize that animal protein – mainly from milk, meat, poultry and eggs

– is more expensive than vegetable protein, as my research on comparative protein cost shows.

The big question therefore is whether animal protein can compete with plant protein cost-to-cost, especially in a price-sensitive country such as ours.

Finally, the animal agriculture-based industry should be clear about where it wants to be in the next ten years. Research is therefore a priority - to study the market and come up with demand projections, strategy to ensure higher yields per milch animal, ways to promote animal health and nutrition, estimation of the number of layers and broilers needed, feed demand, as well as vaccine requirement.

Upgrading skills to keep up with global trends, setting up of adequate processing capacity and investment deserve special attention as the industry has potential to attract foreign direct investment.

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"SUSTAINABLE LIVESTOCK SECTOR: THREATS, CHALLENGES, AND OPPORTUNITIES"

Dr. Surabhi Kumari

Introduction: -

Sustainability is development that meets the needs of the present without compromising the ability of future generations to meet their own needs **(World Commission on Environment and Development, 1987)**. Livestock systems play a critical role in sustainability science due to their significant impact on both the environment and the agricultural economy. Livestock are essential to agriculture worldwide, occupying 30% of the planet's ice-free land and supporting the livelihoods of billions of people. They provide high-quality animal protein and contribute to various ecosystem services, such as enhancing grassland biodiversity and improving soil fertility. However, livestock production also has notable environmental downsides. It contributes approximately 14% of global anthropogenic greenhouse gases through methane emissions, which exacerbates global warming. Additionally, livestock farming consumes land and water resources that could otherwise be used for human purposes and is a major source of land, air, and water pollution. A transformation from the current marginal production system to a more commercial production system is recommended as a sustainable way of livestock production **(Elayadeth *et al.*, 2023)**. To achieve this goal, several research and development opportunities are proposed. Sustainable livestock practices are crucial for both preserving existing ecosystems and improving farming methods that manage natural resources effectively. Increased focus is needed on natural resource management, including the water footprint of livestock, effluent pollution, and the vulnerabilities of pastoral and dryland systems. It is evident that there are significant disparities between current livestock productivity in various countries and the anticipated demand for animal-source foods by 2050. Addressing these gaps is essential for meeting future food needs while ensuring environmental sustainability **(Perry *et al.*, 2018)**.

Important considerations about sustainable livestock production: -

(a.) Biosecurity measures: increased animal-to-animal contact can enhance the transmission of diseases. In intensive ruminant systems, animals from various geographic regions are gathered in feedlots or barns at a single location, allowing pathogens to be introduced from different areas and spread among individuals. While biocides are employed to reduce the incidence and prevalence of pathogens, it is crucial to use them carefully to avoid contamination of meat, milk, or the surrounding environment. Implementing effective biosecurity measures can help prevent disease transmission in livestock, thereby supporting production efficiency and food security.

(b.) Health management: transportation and changes in nutrition are key factors that increase livestock's susceptibility to diseases. The use of antibiotics to treat infections can lead to resistance, complicating future treatment efforts. While vaccines can help reduce the need for antibiotics, they are ineffective if the animal's immune system is compromised. Therefore, it is crucial to focus on proper nutritional management and stress reduction to enhance the immune system and decrease disease prevalence in livestock and thereby promote sustainable production.

c.) Feeding strategies: feeding strategies for livestock should be designed to enhance nutritional status and minimize the release of harmful byproducts and pathogens. Implementing a balanced nutrition plan is essential, as it supports improved immunity and boosts overall production.

(d.) Waste management: to boost livestock production, increasing livestock density is often necessary, but this can also lead to higher pathogen levels. Inadequate waste management can result in contamination of soil, water, and feed. Therefore, effective management of livestock waste is crucial to prevent microbial contamination and maintain a healthy production system.

(e.) Awareness about food safety systems: educating consumers about food safety practices is crucial, as 30%–40% of foodborne illnesses are attributed to improper handling. It is equally important to raise awareness about the health benefits and risks associated with meat and dairy products. Consumers should also be informed about how different production processes impact the environmental factors related to livestock goods.

Global challenges in sustainable livestock production: -

The viewpoint on livestock and related opportunities or challenges as defined in the SOFA **(FAO, 2009)** differs between post-industrial low agricultural growth and emerging economies. Overall, the focus on livestock sustainability encompasses various environmental concerns - including greenhouse gas emissions, carbon footprint, water footprint, animal health and welfare, fodder scarcity, and the impacts of climate change.

(a.) Environmental challenges: environmental challenges primarily involve managing climate change and natural resources while reducing greenhouse gas emissions. The livestock industry accounts for 14.5% of all anthropogenic greenhouse gases annually. Emissions vary significantly among different livestock species and farming systems, with higher production often resulting in lower emissions per unit of product. Generally, intensive systems produce fewer greenhouse gases compared to extensive systems. Enhanced productivity and biodiversity, along with reduced greenhouse gas emissions, can be achieved through improved animal health, better nutrition, and effective management practices.

(b.) Feed and fodder challenges: livestock productivity is significantly influenced by both the quantity and quality of feed. The adverse impacts of rising temperatures and increasing atmospheric carbon dioxide on feed resources are well-documented **(Chapman et al., 2012; Thornton et al., 2015)**, though the extent of these effects varies by location and livestock system **(IFAD, 2010)**. In India, a major policy challenge in livestock production is the growing gap between the demand and supply of feed and fodder, coupled with their declining quality. Present scenario depicts the picture of stagnation in the availability of green fodder. According to estimates from the Indian Grassland and Fodder Research Institute, the demand for green fodder and dry fodder is projected to reach 1,012 million tonnes and 631 million tonnes, respectively, by 2050. The anticipated deficits by 2050 are 18.4% for green fodder and 13.2% for dry fodder **(IGFRI, 2013)**.

c.) Health challenges: health challenges address the "one world, one health" concept, encompassing both human and animal health. Changes in climatic parameters, especially rising temperatures, disrupt the host-pathogen-environment system, thereby impacting animal health both directly and indirectly. Livestock diseases pose significant risks, contributing to poor production and productivity. While well-known infectious diseases can lead to reduced output, endemic diseases also frequently impact animal health. Moreover, infectious animal diseases not only threaten production but can also directly affect human health.

(d.) Enteric emission challenges: enteric fermentation is a digestive process where plant biomass consumed by animals is broken down into volatile fatty acids by microorganisms, such as bacteria, protozoa, and fungi, in the rumen. Methane and CO2, which are waste by-products of this process, are expelled from the rumen through eructation. Among livestock, cattle contribute the most to enteric emissions (51%), followed by buffaloes (42%), sheep (5%), and goats (2%). Although methane emissions per animal in India are lower compared to developed nations, the country has a significant share of the global livestock methane budget due to its large livestock population. Methane emissions are influenced by the quality and digestibility of feed. In India, farm animals primarily consume low-quality roughages

with lower digestibility, resulting in less methane production compared to exotic breeds in developed countries that are fed easily digestible, high-quality feed.

(e.) Economic challenges: economic challenges mainly relate to trade, markets, and less investment in small-scale farms. The basic reasons for poorly developed markets of animal products and by products are information gaps and weak supply chains and poorly constructed taxes and trade policies.

(f.) Social challenges: social challenges in the livestock sector include child labour and gender discrimination. In pastoralist societies, there is a preference for men in labour roles, and child labour is prevalent. In intensive farming systems, conditions for farmers and workers are often poor, with low social status and inadequate working environments.

(g.) Animal welfare challenges: views on animal welfare vary significantly across countries, presenting a major challenge in balancing increased productivity with welfare standards, particularly in developing and often poorly regulated intensive livestock systems. Despite these challenges, retailers and consumers in many high-income countries are increasingly demanding more animal-friendly livestock production practices.

Sustainable livestock production and environment:-

As global awareness of climate change grows, research has increasingly focused on the environmental impacts of livestock, particularly their role in greenhouse gas emissions, environmental degradation, and biodiversity loss. Livestock systems are undergoing numerous coordinated efforts to enhance sustainability, aiming to balance economic and ecological needs while ensuring future environmental health. Ruminants, in particular, are responsible for approximately 90% of livestock-related emissions due to enteric fermentation, with the remaining 10% coming from manure.

Animal scientists have developed various strategies in nutrition, genetics, health, and management to potentially reduce greenhouse gas emissions by up to 30%. Effective mitigation can be achieved through optimized feeding practices, improved manure management, and increased productivity. Specific methods include enhancing the digestibility of roughage, and supplementing diets with prebiotics, organic acids, tannins, saponins, essential oils, and ionophores to lower enteric methane production. Additionally, collecting and utilizing all cattle dung for biogas production could lead to significant reductions in greenhouse gas emissions.

Sustainable Livestock Sector: Opportunities: -

Research and development are integral elements to create a sustainable livestock sector. One of the most promising practices in sustainable livestock production is the integration of technology. These are the few innovative technologies that aid in promoting sustainable livestock sector -

- **Use of genomics-** genomics research focuses on how genetics affect animal biology and health, enabling the development of new breeds and enhanced genetic lines. This advancement can produce animals that are more resilient to disease and climate change while requiring fewer resources. Additionally, genomics holds the potential to improve animal welfare by providing scientists with a deeper understanding of how animals respond to stress and other stimuli.

- **Attaining environmental sustainability-** researchers have developed techniques to mitigate greenhouse gas emissions from agriculture and manage nutrient pollution resulting from animal production. These methods include improvements in animal housing, such as advanced barn designs, as well as changes to animal feed. Ongoing research into these innovations shows promise for creating a more sustainable livestock sector.

- **Promoting smaller-scale farms-** innovations in gene editing and biotechnology offer the potential to create livestock breeds better suited to local climates and more resistant to specific diseases. These advancements could

particularly benefit smaller-scale farmers, enabling them to achieve higher yields while reducing the environmental impact typically associated with large-scale operations.

- **Use of AI tools and software -** advancements in cameras, sensors, networking, and farm management software have empowered farmers to manage their livestock more effectively and make informed decisions. Technology enables farmers to monitor water usage, allowing them to track their water footprint. Additionally, AI-based software and robotic platforms provide the capability to remotely observe and assess a herd's health and behaviour.

- **Use of renewable energy sources-** sustainable livestock production harnesses renewable energy sources to power farms, decreasing dependence on polluting fossil fuels. This approach not only lowers carbon emissions associated with livestock production but also supports the creation of a more sustainable agricultural system. Consequently, the carbon footprint of each animal can be significantly reduced.

- **Development of genetically modified crops-** the development of crops that offer more nutritious fodder for livestock involves modifying them to enhance protein and amino acid content. These improvements optimize animal growth and health by providing a more beneficial feed.

- **Reducing impact of climatic stresses-** improved management of livestock can minimize the activation of thermoregulatory mechanisms, thereby enhancing growth and production. Addressing the effects of climatic stresses on livestock requires a multidisciplinary approach that integrates animal genetics, nutrition, housing, and health.

Approaches for heat stress amelioration in Livestock

Genetic Modifications	Management Strategies	Nutritional Strategies	Disease Management
Genetic selection	Housing strategies	Fat supplementation	Vaccination
Genetic Marker assisted breeding	Sprinklers	Choice feeding	Parasite control
Disease resistant breed	Acclimatization	Protein and amino acid levels	Remove sick animals
Thermotolerant genes	Feeding time and space	Water supply	Separating multi – age flocks
	Feeding at cooler times of the day	Electrolytes and vitamins supplementation	

Source: Sejian et al., 2018)

- **Fodder resource management -** Despite intensive efforts to revitalize fodder resources, there are current deficits of 23.4% for dry fodder, 28.9% for concentrates, and 11.24% for green fodder. The stagnation in green fodder availability is further exacerbated by inadequate fodder seed production, poor market linkages, and a very low seed replacement rate. Effective fodder resource management can be achieved through the following strategies: -

  - Improving the quality of straw
  - Increasing the availability of coarse grains and oil meals
  - Enhancing the production of fodder and fodder seeds
  - Developing compound feed and balanced rations
  - Expanding pasture land and common property resources
  - Implementing Government of India initiatives for fodder resource management

- **Mitigation strategies-** key interventions for improving livestock sustainability include enhancing feed quality and quantity control, optimizing digestion through dietary changes, suppressing enteric fermentation, and implementing methane capture technologies to either generate energy or reduce atmospheric emissions. Additionally, nutrient management strategies that improve soil carbon and farm practices like genetic selection contribute to yield improvements.

Introducing alternative protein sources, such as insects and lab-grown meat, offers a more sustainable option compared to conventional livestock production and helps reduce environmental impacts. Integrating crop and livestock farming is another effective strategy for lowering emissions from animal production. Swapping traditional, carbon-intensive feeds like soybean meal and maize with more sustainable alternatives such as barley and alfalfa can further decrease emissions. These innovations significantly contribute to reducing the carbon footprint of the livestock sector.

Conclusion: -

The growing human population and increasing demand for animal products are driving livestock production towards high-input, intensive systems. Achieving sustainable livestock production is crucial for protecting ecosystems and developing farming practices that conserve natural resources. This involves the dual goals of boosting livestock production while minimizing environmental impact. Researchers and government officials are exploring innovations in sustainable livestock practices to preserve the environment and maintain an efficient food production system. Addressing global warming challenges requires a fundamental shift in agricultural practices and the role of livestock within farming systems. Various genetic, nutritional, and health strategies can mitigate the environmental impact of livestock, enhancing their contribution to sustainable production and food security. However, the main obstacles to achieving sustainability in the livestock sector are more sociological, economic, and political than technical.

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USE OF FEED ADDITIVES FOR IMPROVING POULTRY PRODUCTION

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Introduction

Feed additives are products used in animal nutrition for purposes of improving the quality of feed and the quality of food from animal origin, or to improve the animals' performance and health, e.g. providing enhanced digestibility of the feed materials. In general, the term "feed additive" refers to a non-nutritive product that affects utilisation of the feed or productive performance of the animal which may economise the cost of animal origin foods.

Many feed additives are gaining importance because of increased raw material cost, low market prices of poultry meat and eggs, and government regulations as well as consumer awareness about antibiotics residue in animal origin food.

As mentioned above additives may be nutritive (vitamins, minerals) or non-nutritive (Antibiotics, Probiotics), however, now a days only non-nutritive are considered as additives which will be discussed here. Nutritive feed additives are called as supplements.

Types of feed additives

1. **Enzymes:** These are proteins that act as biological catalysts by accelerating chemical reactions. The molecules upon which enzymes may act are called substrates, and the enzyme converts the substrates into different molecules known as products.

   Following are different enzymes used in poultry feed.

   A) Phytase: This is most widely used enzyme in poultry feed, which makes available phytate bound phosphorous to the birds. Phytate is anti-nutritional factor in plant derived feed which binds minerals and increase amino acid loss through increased intestinal mucus secretion. As phosphorous is costly nutrient, this enzyme saves feed cost. Also, by improving bound phosphorous utilization it reduces phosphorous excretion in faeces reducing the environmental pollution. Apart from phosphorous it also improves the utilization of amino acids and other minerals improving the birds weight gain and feed efficiency.

   B) NSPases: This is group of enzymes that acts on Non starch polysaccharides (NSP). They act in following ways to benefit the bird i) Attenuation of the antinutritive effect (reduced digesta viscosity) ii) reduction of the non-digested portion of the substrate 3) improvement of the growth performance of the chicken by releasing energy from NSP. These enzymes allow Nutritionist to reduce energy cost in formulation.

   In addition, it increases production of short chain fatty acids like butyrate which are important for gut health. Examples of NSPases are xylanase, β mannanase, β Glucanase.

   Some enzymes like α galactosidases which act on oligosaccharides (present in beans) are also gaining importance.

   C) Protease: Act on proteins and makes it highly digestible by breaking peptide bonds. Use of Protease is also not uncommon now a days, because of shifting from high to low protein diets and increased prices of the protein sources (for example- Soya DOC).

Also, it reduces nitrogen excretion through faeces reducing litter quality issues N and pollution. It also reduces amount of undigested protein entering large intestine which otherwise will be used by harmful bacteria for growth (protein fermenters).

D) Recently some enzymes are also used for mycotoxins biotransformation to non-harmful metabolites.

2. **Emulsifiers:** Emulsifiers improve fat utilization and digestion in poultry. They work by breaking down and dispersing fat molecules into smaller droplets, making them more available for absorption. Bile is natural emulsifier produced in liver.

   Examples of emulsifier include soy-lecithin, lysophatidylcholine or lysolecithin, bile salt, glycerol polyethylene glycol ricinoleate, and sodium stearoyl-2-lactylate (SSL) etc. Some emulsifiers also increase pellet mill output saving the power consumption.

3. **Antibiotics:** These are substances which are produced by living organisms (mould, bacteria) and which in small concentration have bacteriostatic or bactericidal properties. They were originally developed for medical and veterinary purposes to control specific pathogenic organisms.

   Their use in feed is now restricted in India as due to continuous use antibiotic resistant microbes are evolved which are difficult to control and causing health issues in humans too.

4. **Anticoccidial medicines:** Various ionophore and chemical compounds are used to prevent coccidiosis. However, it should be changed frequently (within two months) to avoid the resistance.

5. **Probiotics (Direct fed microbials) :** Probiotics are live bacteria, fungi, or yeasts that supplement the gastrointestinal flora and help to maintain a healthy digestive system, thereby promoting the growth performance and overall health of poultry (Jha et al 2020). How they act?

   A) Having a direct antagonistic effect against specific group of undesirable or harmful organism through production of antibacterial compounds, competition for the nutrient and or attachment site.

   B) Some microbes release enzymes which help in digestion

   C) Stimulation of immunity

   Examples – Bacillus (bacteria), Saccharomyces (yeast)

6. **Prebiotics:** Prebiotics are known as non-digestible carbohydrates that selectively stimulate the growth of beneficial bacteria, thus improving the overall health of the host. Once prebiotics are introduced to the host, 2 major modes of action can potentially occur. Initially, the corresponding prebiotic reaches the intestine of the chicken without being digested in the upper part of the gastrointestinal tract but are selectively utilized by certain bacteria considered beneficial to the host. Secondly, other gut activities occur due to the presence of the prebiotic, including generation of short-chain fatty acids and lactic acid as microbial fermentation products, a decreased rate of pathogen colonization, and potential bird health benefits (Ricke et al 2020). In addition they can bind mycotoxins.

   The commonly used prebiotics are MOS (Mannan oligosaccharides), FOS (Fructan oligosaccharides.

7. **Antioxidants:** Antioxidants are compounds that scavenge free oxygen radicals preventing oxidative rancidity. Rancidity once develops, may cause destruction of vitamins A, D and E and several of the B complex vitamins. Breakdown products of rancidity may react with lysine and thus affects the protein value of the ration.

   Examples- Ethoxyquin, BHT (butylated hydroxyl toluene), BHA (butylated hydroxyl anisole) \

8. **Organic acids:** Chemically, organic acids are weak acids and only partially dissociate. They

are considered safe and have been used for preservation of food for centuries. Nowadays, organic acids have been reported for antibacterial, immune potentiating, and growth promoters in broilers. Propionic acid, formic acid, citric acid, and acetic acid are promising alternatives to antibiotics. Their inclusion in the broiler feed has been shown to enhance the feed intake, growth, and feed efficiency (Khan et al 2022).

9. **Toxin binders:** Mycotoxin binders are nutritionally inert substances added to animal feed to tightly bind and immobilize mycotoxins in the gastrointestinal tract of animals, thus reducing their bioavailability. This process is known as adsorption, and it constitutes the most well-known approach to detoxification of mycotoxins.

   But this can't provide 100% protection and farmer should be very cautious about the raw material quality.

10. **Phyto-Chemicals:** Several Phytochemicals or plant secondary metabolites are used in animal industry. Secondary metabolites are compounds naturally produced by plants, that are not involved in the primary growth and development of plants. However, they help plants in several processes like reproduction and protection from pests and pathogens. Most of them like essential oils, flavonoids, tannins have antibacterial activity. Saponins are anti-protozoal and ammonia binder.

11. **Pigments:** Pigments are used in birds for the improvement of the final product according to consumer preferences, without altering the normal metabolism of animals. Birds can store pigments in yolk, fat deposits, skin and in their legs. It has been proven that color is associated with palatability amongst consumers. Therefore, alterations in color can be associated with better taste, or may cause rejection.

    Examples- red pigments: citranaxanthin, capsanthin; yellow pigments: Apo-ester, zeaxanthin.

12. **Flavours:** Flavors are a series of diverse compounds that aim to increase feed intake in sensitive animals, especially young ones. Despite the low number of taste buds in chickens, they also appear to benefit from using flavoring agents in their diet. While using unconventional bitter raw materials in feed sweet flavouring agents (molasses like flavour) may help to avoid drop in feed consumption.

13. **Pellet binders:** Pellet binders are products that are used to hold the various feed components together in order that they will maintain pellet integrity during subsequent operations after they are extruded from the pellet die. Many products are available in market, but farmer should use only if necessary i.e. if powder % is more than 5% in pellets.

Conclusion

As mentioned above there are several feed additives with different purpose are available in market, it optimizes nutrient utilization reducing the feed cost and some additives like probiotics, organic acids, phytochemicals, enzymes are helpful in without antibiotic feed formulation, however, farmer should go with which is suitable for his business.

Before using any such product don't trust blindly, consider following things:

A) Returns on investment.

B) Certificate of analysis from the competent laboratory.

C) Any trial reports available?

D) Conduct your own trials with small feed quantity before using in all feed.

E) Consult your Animal Nutritionist for efficient bird's performance and profitability.

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BLACK SOLDIER FLY LARVA MEAL - A POTENTIAL PROTEIN SOURCE IN POULTRY DIET

M.V.L.N. Raju, S.V. Rama Rao and R.N. Chatterjee

Insects as food and feed have gained considerable interest in recent times due to the rising cost of animal protein, food and feed insecurity, environmental pressures, population growth and increasing demand for protein (FAO, 2013). Among the insects, Black Soldier Fly (BSF) *(Hermetia illucens)* is an environmentally friendly and highly efficient converter of bio-waste into valuable protein and fat rich animal feed. The fly offers a great eco-friendly and practically feasible strategy that fits well into the sustainable food production and circular economy.

Unique characteristics of Black Soldier Fly

Adult – doesn't bite or sting, doesn't act as vector or disseminate any disease, beneficial fly, non-pest, doesn't feed, no mouth parts, survives on body fat accumulated during larva stage (3 wks).

Larva – self harvesting, doesn't absorb mycotoxins and medicines/residues in the biological waste/food, heavy metals though might be absorbed, saprophagy (25-500mg/larva/day), FCR – 2.2 and reduces manure volume by 58% and fly menace by 94-100%. The larva also has potential to reduce the numbers of E.coli, Salmonella enteritidis etc. in poultry manure (Erickson et.al, 2004).

Dried BSF larva

BSF larva meal

Black Soldier Fly Life cycle

The whole life cycle of BSF spans over a period of 35-55 days (larval stage 10-25 days depending on the biomass/feed availability; pre-pupal stage 7-10 days; pupal stage 8-10 days and adult stage 8-9 days). During its life, the insect feeds only during the larval stage and doesn't feed during the rest of her life including the adult stage. The larva before it proceeds into the pre-pupal stage is best suited for feeding poultry, aqua and animals.

Nutritional profile

The BSF larvae are rich in crude protein (41.0 – 43.6%), crude fat (15.0 – 35.0%) and ash (14.6 – 28.4%), and high in energy (5200-5400 Kcal/kg gross energy) (Arango Gutiereez et al., 2004; St-Hilaire et al., 2007). The amino acid profile indicates higher concentrations of valine, leucine, alanine and glutamine. The average apparent ileal digestibility coefficient of amino acids also is moderate (0.68, Marco et al., 2015) to very high (0.85-0.95, Matin et al., 2021; 0.84-0.91, Mahmoud et al., 2023) in BSF larva meal. The rich oil content in larva has high concentration of lauric acid, which is known to help in improving immunity. The larvae are also rich in calcium (Ca, 2.5-3.0%) and phosphorous (P, 0.4-0.5%), besides having moderate amounts of other minerals such as potassium (K, 0.6%), iron (Fe, 0.1-0.3%), manganese (Mn, 0.2-0.3%), zinc (Zn, 0.01-0.07%)) and copper (Cu) (Zulkifli et al., 2022; Zozo et al., 2022; Vasilopoulos et al., 2024).

It is however important to note that the nutrient composition of biomass produced using BSF larvae depends greatly on the feed substrates used for growing the larvae. Therefore, the nutrient profile of BSF larvae meal (BSFLM) varies considerably based on the obvious reasons listed. Most pragmatic approach to denote the tentative nutritional profile of the BSFLM is by indicating the bio-mass fed to the specific batch of meal produced. In line with this, in a study conducted at our lab (Raju et al., 2023), the nutrient profile of BSFLM was found to vary greatly amongst the samples obtained from 3 different sources (crude protein: 49.8 to 59.6%, crude fat: 12.0 to 38.4%,

lysine: 2.4-4.7%, methionine: 2.3-4.6%, lauric acid: 15.2-62.4%) (Table 1). This could be possibly due to the different substrates used at the production units for the larva production and or different production/processing methodologies adopted.

Table 1. Composition (% dry matter) of Black Soldier Fly larval meal (BSFLM) from different sources in comparison to soybean meal (SBM)

	BSFLM samples				SBM
	A	B*	C	D*	
Moisture	15.6	4.2	4.4	4.5	7.6
Crude protein	49.8	59.6	50.2	53.0	45.4
Crude fat	35.2	22.1	38.4	12.0	0.9
Amino acids					
Alanine	1.2	2.5	2.3	1.2	2.0
Arginine	1.8	3.5	4.8	3.2	3.4
Aspertic acid	3.4	6.3	5.7	5.3	5.4
Cysteine	-	-	-	-	0.6
Glutamic acid	3.1	8.0	8.8	7.5	8.5
Glycine	-	-	-	-	2.0
Histidine	0.4	1.2	1.2	1.1	1.2
Leucine	1.0	1.9	1.5	2.1	3.6
Lysine	2.4	4.3	4.7	3.1	2.8
Methionine	2.3	2.7	3.0	4.5	0.6
Phenyl alanine	1.4	2.2	2.5	2.8	2.5
Proline	4.3	8.7	6.9	8.0	2.5
Serine	2.1	4.9	4.7	4.0	2.4
Threonine	1.5	2.7	2.6	2.7	1.8
Tryptophan	-	-	0.1	0.1	0.7
Valine	2.9	4.0	2.8	3.3	2.2
Fatty acids (% of total fatty acids)					
Capric acid (C10: 0)	1.31	1.32	0.32	0.44	
Lauric acid (C12: 0)	48.44	62.42	15.24	17.28	
Myristic acid (C14: 0)	0.85	0.03	0.08	0.85	
Palmitic acid (C16: 0)	17.39	9.30	26.39	31.66	
Stearic acid (C18: 0)	3.54	3.09	4.75	5.31	
Behenic acid (C22: 0)	0.10	0.11	0.13	0.30	
Total saturated	71.63	76.26	46.91	55.85	
Palmitoleic acid (C16: 1)	6.45	0.77	2.49	2.94	
Oleic acid (C18: 1)	16.71	14.95	26.19	17.29	
Linoleic acid (C18: 2)	5.17	7.43	24.34	23.75	
Linolenic acid (C18: 3)	-	-	0.07	0.04	
Erucic acid (C22: 1)	0.05	0.58	-	0.13	
Total unsaturated	28.37	23.74	53.09	44.15	

On DM basis *partially defatted

Raju et al. (2023)

The exoskeleton of BSF larva contains chitin, a constituent of cell wall, which doesn't hydrolyse in the chicken gut due to the lack of specific proteolytic enzyme and thereby inhibits nutrient utilization in chicken. The methods like physical separation of exoskeleton and fermentation with chitinolytic bacteria like Bacillus subtilis (Nafisah et.al. 2019) may be explored for reducing the chitin content of BSF larvae.

BSF larva meal in poultry diet

The BSF larvae or their meal have been explored in the recent past as potential alternate sources of animal protein in poultry diet, partially substituting soybean meal or fishmeal. Live BSF larvae, when scattered on the litter, increased levels of welfare and behaviour, and improved leg health in broiler chicken (Ipema et al., 2020). Organic broilers fed diet containing BSF larva, but with 20% less lysine content, grew equally well as that of control (Heuel et al., 2022).

Dietary inclusion of BSFLM was reported to improve growth performance (Lee et al., 2018) and feed conversion efficiency in broiler chicken (Vilela et al., 2021). Beneficial effects on meat quality were also noted with BSFLM in broiler diet (Altmann et al., 2020) besides improved carcass weights at market age (Schiavone et al., 2019). At 5% in diet, BSF pre-pupae meal was reported to show similar growth and feed efficiency in broiler chickens and not to affect intestinal morphometry and crude protein digestibility in broiler chickens (Elangovan et al., 2021). Furthermore, the oil obtained from BSF larvae also is a good source of energy and was identified to be an effective substitute for soybean oil in broiler chicken diet (Schiavone et al., 2017).

Full fat dried BSF larvae, when included in laying hen diet at 10 and 18 % replacing soybean meal, no adverse effects were observed on the sensory attributes of the eggs, though the yolk fat content increased as the BSF larvae content increased in feed (Bejaei and Cheng 2020). Similarly, in broiler chicken, BSF larvae meal upto 10% in diet did not adversely affect meat quality, instead the meat was slightly more yellowish and had slightly low pH, and increased saturated fatty acid content in thigh meat (Altman et.al. 2020).

Like in broilers, supplementing live BSF larvae to laying chicken on top of a soya-free diet improved feather condition and behavioural patterns (Star et.al. 2020). The protein and protein hydrolysates of BSF larvae contain short-chain peptides, which are known to possess antioxidant behaviour in animals and thereby protect the animal cells from oxidative damage (Mouithys - Mickalad et.al. 2020).

The BSF larvae also favourably influence immunity in chickens. Increased frequency of CD4, T-lymphocyte, serum lysozyme activity and spleen lymphocyte proliferation, besides reinforced bacterial clearance and increased survivability Salmonella gallinarum were reported (Lee et al., 2018). The dietary inclusion of BSF larvae has profound positive effect on the gut health (positive influence on gut histomorphometry, caecal microbiota or the gut mucin dynamics, and increase in villa mucins at low levels of inclusion, i.e.5%) (Biasato et al., 2020).

In our study (Raju et al., 2023), body weight gain and feed intake of broilers increased linearly with BSFLM upto 5.0% in diet during early life (0-3 weeks). At higher levels of BSFLM (7.5 and 10% in diet), significantly depressed growth was observed, while FCR showed only non-significant difference (Table 2). Dressing yield, breast weight and abdominal fat content increased linearly with BSFLM level in diet, while other organ weights, serum biochemical profile and cell mediated immune response to PHA-P inoculation were unaffected.

Table 2. Effect of graded levels of BSF larva meal (BSFLM) in diet on performance of broiler chicken at 6 weeks

	BSFLM, % in diet				*P*	*SEM*
	0	5.0	7.5	10.0		
Body weight gain, g	2349^{a}	2329^{ab}	2274^{bc}	2239^{c}	0.008	24.178
Feed intake, g	3628^{a}	3609^{a}	3532^{ab}	3498^{b}	0.023	33.379
FCR	1.545	1.550	1.554	1.562	0.241	0.003
Dressing yield, g/kg	785.0	798.4	801.8	817.7	0.204	10.683
Breast weight, g/kg	270.9	273.7	273.7	283.6	0.133	4.000
Abdominal fat	9.81^{b}	13.66^{a}	13.88^{a}	13.19^{a}	0.027	1.051

Raju eta al. (2023)

Aqua and pet food

BSF larva/meal has high potential in shrimp feed (can replace upto 60% of fish meal) and pet food (6-13% in diet).

Additional benefit : Reduced house fly problem in poultry farms

BSF are known to reduce house fly numbers by competition for survival (Sheppard, 1983) when introduced in the poultry manure.

Institutes working on BSF in NARS

Various ICAR institutes and Veterinary/Agriculture universities are currently working on BSF. To name a few, ICAR-DPR, Hyderabad; ICAR-NBAIR, Bengaluru; ICAR- NIANP, Bengaluru; PJTSAU, Hyderabad; AFAL, TANUVAS, Namakkal; UAHS, Shivamogga, Karnataka, etc.

Volume of production

In Europe, the production of BSF larva has received great attention, which could be primarily due to the low environmental impact of insect rearing vis-à-vis agricultural crop production. The production of insect meal in Europe was estimated to be about 5000 metric tonnes in 2018, which is projected to increase to 3 million tonnes by 2030 (Schaer, 2022). In a different estimate, it is projected at 8 million tonnes by 2033 with a market value of 3.96 billion USD (Meticulous Research, 2022). Commercial production of BSF larva has been taken up in Europe and the agencies (like FreezeM of Israel) are working on the genomics of the larva, its value addition and the processing methodologies.

In India, the activity is in the primitive stage and the authentic data on BSF larva production volume is not available. Several enthusiastic entrepreneurs have ventured into the commercial production of black soldier fly larvae in the past few years, some of whom are : KovaiBSF, Coimbatore; Insectifii, Bengaluru; Intulse Technologies, Gandhinagar; Arthro Biotech, Hyderabad; MAHYCO, Jalna, Maharashtra; Holocene Ecosolutions, Hyderabad; Venkataramana Poultry, Andhra Pradesh; Super Enviro Farms, Hyderabad; Loopworm, Bengaluru; Hindustan Protein, Coimbatore; ZEWA Ecosystems, Kerala; Insectika, Bhubaneshwar; Green Grahi Solutions, Uttarakhand; Ento Proteins Pvt. Ltd, Mangalore, etc. Besides, many other startups/small scale entrepreneurs have been standardizing the production processes.

Available regulations

As per FAOLEX, BSF larva can be used as feed for farm animals and pets. But the food for larva must be of non-animal origin and manure is not to be used (Wang and Shelomi, 2017). As per AAFCO (Assn. of American Feed Control Officials), food for larva must be of feed-grade. In EU, BSF larva was approved for feeding to poultry and pigs in 2020, while for aqua feeding, it was approved before in 2017.

Challenges ahead

Currently, BSF larvae are mostly being produced on pilot scale in limited quantities in the country. The production process needs to be further refined for increasing the volumes and thereby meeting at least partially the needs of large scale commercial poultry sector. Also, the significant effect of substrate fed to the larva on its nutrient profile needs to be addressed for ensuring optimum quality and avoiding the associated issues in feed formulation.

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FEEDING VIKSIT BHARAT: FEEDING THE CHICKEN :

Mr. Suresh Rayudu Chitturi*

1. Introduction: The Vision of Viksit Bharat

India's journey towards becoming a developed nation, or "Viksit Bharat," is deeply intertwined with self-sufficiency in food production, food security, and robust economic growth. The poultry industry plays a crucial role in this vision by providing high-quality protein and economic stability to millions of farmers. As the demand for poultry products continues to rise, driven by a growing population and increasing incomes, India faces the dual challenge of expanding poultry production while ensuring the availability of raw materials necessary to sustain this growth.

2. Current Poultry Production in India (2024)

- Layers: 350 million layers
- Broilers: 110 million broilers produced weekly
- Egg Production: 120 billion eggs annually
- Meat Production: 4.5 million metric tons of chicken meat annually
- Economic Contribution: 3-4% of India's agricultural GDP; employs over 25 million people

3. Projected Poultry Production in India by 2047

- Layers: Expected to reach 1.3 billion
- Broilers: Projected weekly production of 250-300 million
- Egg Production: Sufficient to meet protein needs
- Meat Production: Expected to rise to 41.52 million metric tons annually

4. Protein Requirements from Chicken in India by 2047

- Total Annual Protein Requirement: 45.67 million metric tons
- Contribution from Chicken: 9.134 million metric tons (20% of total)
- Total Chicken Needed: 41.52 million metric tons

5. Protein Requirements from Eggs in India by 2047

- Contribution from Eggs: 4.567 million metric tons (10% of total)
- Total Eggs Needed: 614.36 billion eggs annually

6. Feed Requirements for 2047

Meeting the projected poultry production targets by 2047 will require substantial amounts of feed. The feed requirements for both layers and broilers are crucial components of the production process and must be carefully managed to ensure both efficiency and sustainability.

- **Total Feed for Layers:**
- Projected Feed Requirement: The total feed required to support the production of approximately 614.36 billion eggs annually is estimated to be 78.74 million metric tons.
- Grain Requirement: Layers will need about 43.31 million metric tons of grains annually, which forms the bulk of their diet.
- Protein Requirement: Approximately 23.62 million metric tons of protein sources, such as soymeal or other high-protein feed ingredients, will be necessary to meet the nutritional needs of laying hens.
- Other Components: To balance the diet and ensure optimal health and productivity, around 11.81 million metric tons of other feed components, including vitamins, minerals, and additives, will be required.

- **Total Feed for Broilers:**
- Projected Feed Requirement: The feed necessary to produce 41.52 million metric tons of chicken meat annually is estimated to be 100 million metric tons.
- Grain Requirement: Broilers, which have a high growth rate, will require 65 million metric tons of grains to ensure rapid weight gain and efficient feed conversion.
- Protein Requirement: To support muscle development and overall growth, broilers will need approximately 30 million metric tons of protein-rich feed.
- Other Components: An estimated 5 million metric tons of additional components, such as fats, minerals, and feed additives, will be necessary to optimise the diet and promote health and productivity.

- **Total Feed for Poultry (Layers and Broilers Combined):**
- Overall Feed Requirement: When combined, the total feed requirement for both layers and broilers in India by 2047 is projected to be 178.74 million metric tons annually.
- Grain Requirement: The poultry industry will need a staggering 108.31 million metric tons of grains annually to meet the dietary needs of the birds.
- Protein Requirement: The total protein feed requirement across both layers and broilers is estimated at 53.62 million metric tons.
- Other Components: A combined total of 16.81 million metric tons of additional feed ingredients will be required to ensure the birds' diets are nutritionally balanced and conducive to optimal productivity.

7. Addressing the Raw Material Challenge: Meeting the Demand of India's Poultry Industry

As India advances toward the vision of Viksit Bharat, the poultry industry emerges as a cornerstone of the nation's food security strategy, poised to meet the burgeoning demand for protein. However, with this opportunity comes a significant challenge: ensuring the availability of the raw materials required to support the industry's growth.

Rising Demand for Raw Materials:

The poultry sector's expansion, driven by the need to produce 41.52 million metric tons of chicken meat and approximately 614.36 billion eggs annually by 2047, will necessitate a substantial increase in the supply of key raw materials. The total feed requirement for poultry, projected to reach 178.74 million metric tons annually, underscores the scale of this challenge. This includes:

- Grains: Approximately 108.31 million metric tons of grains will be needed annually to meet feed demands.
- Protein Sources: An estimated 53.62 million metric tons of protein-rich feed components will be required.
- Other Feed Components: Around 16.81 million metric tons of other essential components must be secured.

Current Limitations and Challenges:

India's agricultural productivity for key feed crops like corn and soybeans lags significantly behind leading global producers:

- **Corn Productivity:**
- In India, corn yields are between 3-4 tons per hectare, compared to 10-12 tons in the USA and 6-7 tons in China. This results in a total production of only 25-30 million metric tons annually, far below the 350+ million tons produced in the USA.
- **Soybean Productivity:**
- Soybean yields in India range from 1.2-1.5 tons per hectare, whereas Brazil achieves 3.2-3.5 tons and the USA reaches 3-4 tons per hectare. Consequently, India's total soybean production is 10-12 million metric tons, compared to over 100 million tons in the USA and Brazil.
- **Efficiency Factors:**
- India's agricultural sector is characterised by low mechanisation, reliance on rain-fed agriculture, and small farm sizes. These factors contribute to lower yields and overall productivity, making it challenging to meet the growing demand for poultry feed.

Opportunities for Innovation and Growth:

To address these challenges, India must capitalise on several opportunities:

- **Enhancing Crop Yields:**
- Investment in agricultural research and development (R&D) to improve crop yields is essential. This includes adopting advanced seeds, modern farming techniques, and efficient irrigation methods used in higher productivity countries.
- **Diversification of Feed Sources:**
- Exploring alternative feed sources, such as insect protein, algae, and agricultural by-products, can reduce reliance on traditional grains and protein sources. This not only alleviates pressure on existing crops but also contributes to sustainability.
- **Sustainable Practices:**
- Emphasising sustainable farming practices that enhance soil health, reduce water usage, and minimize the carbon footprint will be key in meeting the rising demand without exacerbating environmental challenges.
- **Strengthening Supply Chains:**
- Building more resilient and efficient supply chains will reduce waste, lower costs, and ensure a steady flow of raw materials to the poultry sector. This includes investments in infrastructure, cold storage, and logistics.

Collaborative Efforts for a Resilient Future:

The magnitude of the raw material challenge necessitates a coordinated effort across various sectors:

- Government Initiatives: Policy support in the form of subsidies, incentives for sustainable practices, and investment in agricultural R&D will be critical in driving the necessary advancements.
- Private Sector Involvement: The private sector, including agribusinesses and poultry producers, must invest in technology, innovation, and infrastructure to support raw material production and supply.
- International Collaboration: Leveraging global expertise, importing advanced technologies, and forming strategic partnerships with other nations can help India overcome its raw material challenges.

8. Conclusion: Feeding Viksit Bharat

The journey toward Viksit Bharat is intricately linked with the evolution of India's poultry industry. Meeting the projected demand of 41.52 million metric tons of chicken and ensuring the production of approximately 614.36 billion eggs by 2047 will require a concerted effort to improve efficiency, embrace sustainable practices, and harness technological innovations. By doing so, the poultry industry will not only contribute to India's food security but also play a pivotal role in its economic development, bringing the vision of Viksit Bharat closer to reality.

The challenge of producing sufficient raw materials to support this growth is formidable, but with coordinated efforts across government, private sectors, and international partnerships, India can overcome these obstacles. By investing in innovation, enhancing agricultural productivity, and creating a resilient supply chain, the country can ensure that the poultry industry thrives, feeding a growing nation and supporting its aspirations for a prosperous future.

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CELLULAR AQUACULTURE: FISH CELL LINES AS A KEY TO SUSTAINABLE SEAFOOD PRODUCTION

GOWHAR IQBAL [1]*

Aquaculture plays a critical role in global food security but faces challenges related to sustainability, including resource use and environmental impact. Cellular agriculture involves the creation of agricultural products using cell cultures instead of whole plants or animals. The issues of traditional animal husbandry, such as those related to public health, the environment, and animal welfare, have drawn more and more attention to this technique as a potential solution. Cell culture systems enable precise control over growth conditions, thereby reducing resource consumption and waste generation. The idea of creating seafood from farmed fish tissues and cells is also beginning to take hold as a viable strategy to deal with related problems in marine capture and industrial aquaculture. Lab-grown meat presents a promising avenue for sustainable growth in aquaculture, offering solutions to critical challenges faced by traditional seafood production.

Fish cell lines (FCL) have become valuable tools in transgenic, reproductive, toxicological, drug development, genetic environmental and virology research in aquaculture. In the past few years, there is urgent need to development of transgenic fishes for improving various commercial trait (growth, meat quality, disease resistance) to meet the global demand through increasing production and utilization of fish cell line for transgenic studies drastically increased. FCL plays a very vital role in investigation of basic fish biology and molecular biomarker development. In aquaculture to increase the production there is need to raise the fish spermatozoa's quality as well as oocyte which indirectly improve the fertilization and survival in culture practices. Various researcher transplanted germ cells in fish showed that surrogate broodstock could be produced in the aquaculture systems. The introduction of CRISPR/Cas9 technology represented a groundbreaking advance in molecular biology, providing a precise and effective means to induce specific mutations in the genomes of various living cells. Since its inception, a wide range of gene editing strategies utilizing CRISPR/Cas9 have been extensively utilized in mammalian cell lines. However, there remains relatively limited documentation regarding genetic manipulation in fish cell lines. Recently, genome editing technologies have been employed to knockout MSTN across multiple fish species, encompassing both model organisms and marine fish.

The use of fish cell line models has proven invaluable in detecting viral infections and safeguarding the health of key aquaculture species. A crucial method in identifying major pathogens causing viral diseases in various fish species and other organisms involves isolating viruses using these fish cell lines. Therefore, leveraging fish cell lines for such purposes is essential for developing effective control methods to prevent the spread of viral illnesses. The isolation and propagation of viruses using fish cell culture have significantly facilitated the study of viral diseases in important aquaculture species. At the core of a cell culture-based virus surveillance system lies the ability to propagate viruses within this system.

Genetically modified fish cell lines hold significant potential for various biotechnological and clinical purposes. Ultimately, combining cell lines and cell culture systems holds significant promise for enhancing aquaculture resilience and sustainability, thereby supporting long-term seafood production sustainability and mitigating environmental impacts. Thus, it is essential to scale up fish cell culture systems in order to reap the potential benefits of using fish cell cultures in cell-

based aquaculture.

Efforts have been made to develop cell lines from crustacean tissues with the goal of improving their isolation and maintenance techniques. While short-term cultures are suitable for laboratory-scale studies, they must meet the requirements for long-term objectives associated with mass production and commercialization in cell-based seafood applications. To fully realize their potential, advancements in cell-based seafood research require a deeper understanding of fish muscle cell and tissue culture. This includes exploring customized serum-free media formulations suitable for fish cell cultures and designing bioreactors optimized specifically for the needs of fish cells in industrial manufacturing settings.

Studies focusing on the molecular mechanisms of cell-based systems will provide crucial research data for producing fish through cellular methods. Investigations into harvested muscle tissues from freshwater and marine fish offer intriguing insights into establishing muscle cell culture systems. Research must delve deeper into the biology of fish muscle cells, including their growth mechanisms, nutrient requirements, and cellular signaling pathways. Therefore, research efforts should prioritize sustaining these cells over extended periods to facilitate progress toward achieving these objectives.

Lab-grown meat presents a promising approach to sustainable growth in aquaculture by addressing critical challenges faced by conventional seafood production. Cultivating fish meat from cell cultures reduces the environmental impact associated with large-scale fishing and aquaculture operations. It also alleviates pressure on wild fish populations, conserving marine ecosystems and promoting biodiversity. As technology continues to advance, lab-grown seafood has the potential to transform the aquaculture industry, ensuring a sustainable and ethically responsible food supply for future generations while addressing urgent environmental and ethical concerns.

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